

FLORIDA'S PROPAGATION REPORT

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Coordinates: Lat. 26.33, Long. 80.07

Lat. 28.06, Long. 82.42

Angle to ACTS: El. 52.1°

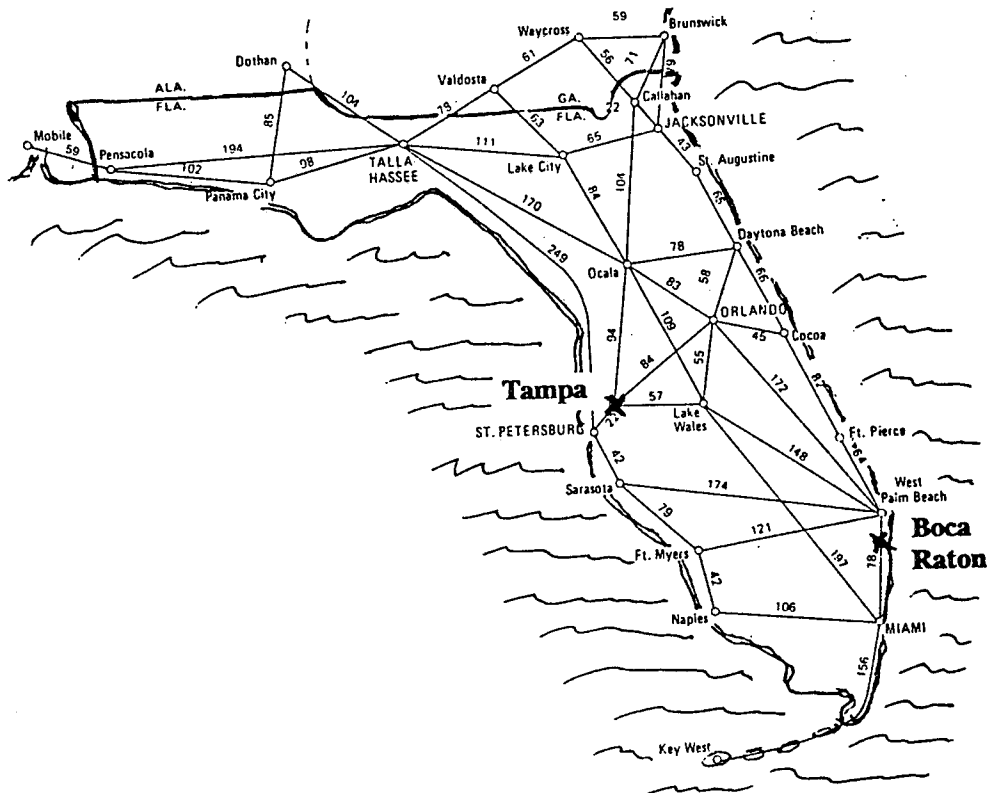
El. 52.1°, Az. 214.0°

Tasks:

Propagation Modeling
Obtain supplementary Data
Measure ACTS Beam Response
Data Analysis & Validation

Obtain Continuous Data for Florida
Submit Pre-processed Data to Un. of TX
Data Analysis

Locations:



Terminals: "Custom" Terminal
20 GHz RF Section,
3.36 GHz I.F.,
Spectrum Analyzer, Macintosh
Computer, 1.2 m Antenna

"Standard" ACTS Propagation Terminal
20 & 27 GHz RF Section,
70 MHz I.F.,
Digital Receiver, IBM-Compatible
Computer, 1.2 m Antenna

I. UNIVERSITY OF SOUTH FLORIDA

A. FOCAL POINTS:

1. Equipment Operation:

Major effort is still being expended on obtaining reliable data and on establishing confidence that the data obtained is truly valid. Section C discusses a number of still outstanding issues in some further detail. On the hardware side this includes the meteorological instruments, proper operation under power-outage conditions, and verifying that the equipment is sufficiently temperature stable. On the software side, verifying that pre-processing (and its relation to equipment calibrations) is sufficiently reliable still needs to be established.

2. Sub-tropical Weather and Climate Related Information:

One of the key goals of the Florida Center is to obtain a maximum of useful information on propagation behavior unique to its sub-tropical weather and sub-tropical climate. Such weather data and information derived therefrom is of particular interest when it is (or has the potential to become) useful for developing and implementing techniques to compensate for adverse weather effects. Florida's unique climate, with its tropical summer pattern provides an opportunity to obtain significant tropical data, which is currently scarce. Its winter climate more closely resembles that of moderate climate zones. The combination appears to have the potential of providing a basis for evaluating designs and equipment destined to function in both climate environments. Some of the data presented in Section B. begins to address this area. We need to warn the reader that our weather in the last year has been quite abnormal, with much lower than normal rainfall. Thus the data presented cannot be considered truly representative of the statistical behavior for this area. See Figure I-1 below.

ampa bay AND state

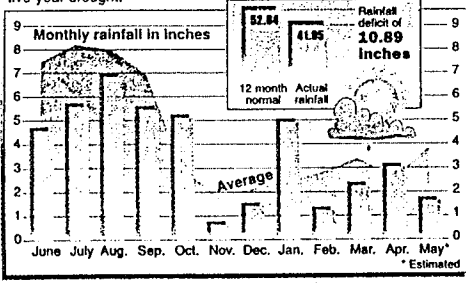
section **B**

WEDNESDAY, JUNE 1, 1994

This dry May was the driest of all

Rainfall totals are falling short

May hasn't been the only dry month in the past year. Since June, rainfall has been only 79 percent of normal, worsening the effects of a five-year drought.



Source: Southwest Florida Water Management District

Times staff

■ Last month was the exclamation point on the region's sentence of dry weather.

By SUE LANDRY
Times Staff Writer

Drought-weary residents looking to the skies for relief instead got the driest May on record.

Barely enough rain fell at Tampa International Airport last month to be recorded by the rain gauge.

The official May total amounted to a scant 0.07 inches of rain, which makes May 1994 the driest May this century in the Tampa Bay area.

It was nearly as dry in nearby counties. The average May rainfall across Swiftmud's 16-county district was just 0.85 inches, nearly matching a record for the district.

"May is when we typically see our driest conditions because it's at the end of the eight-month dry season," said Gary Florence, resource

data director with Swiftmud, the Southwest Florida Water Management District. "But to see a very dry May during our driest time of the year is particularly alarming."

The news that May was extremely dry might come as a surprise to residents whose Memorial Day picnics were drowned by heavy thunderstorms, but the showers were scattered, at best.

Swiftmud offices in Brooksville, for example, got no rain. Less than 10 miles north, a site on U.S. 98 got 2.98 inches during the holiday storms. An area in Tampa got just 0.03 inches of rain, while another area just east of Tampa got 1.74, according to Swiftmud records.

It's the area had inches, drought. Rain below normal. Rainfall for the past five years is 30 inches below normal. The drought has hit especially hard in Tampa and most

entire of 3.82 for the inches es. The

Figure I-1

3. Rapid Signal Variations:

While equipment design must strongly consider longer term, statistically based information, equipment operation will be distinctly influenced by rapid (short-term) signal behavior (time intervals from milliseconds to several hours). Very little data seems to be available in this area. Obtaining such information on our unique summer weather, with its sudden, highly local, intense storms, is considered very important. Therefore we are focusing particular attention on rapid signal variations caused by both "weather" and "scintillation". Data presented in Section B. also begins to address this area.

B. DATA OBSERVATIONS:

1. Sub-Tropical Weather and Climate Related:

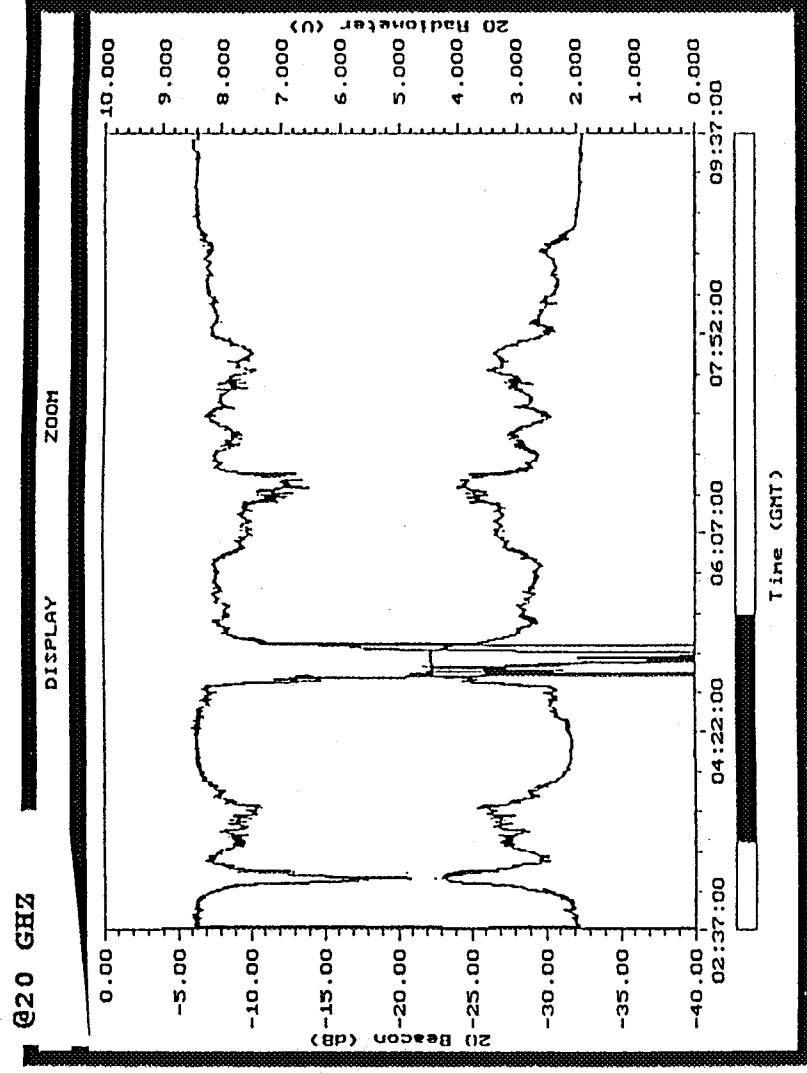
This section provides brief comments on the observed data presented in the figures that follow.

Figure I-2. presents an example of a winter weather "event", typically caused by a continental weather front reaching into and passing across Florida. Passing of a "front" normally lasts from several hours to over a day. Our (limited) observations to date show that there is only a brief interval (normally a few minutes) in which the beacon signal was completely lost (> 35 db increase in attenuation). The 27.5 GHz signal is invariably lost sooner and for a longer time interval than the 20.2 GHz signal.

Figure I-3. presents the first severe summer thunderstorm. It is an example of a typical summer weather "event". These storms are formed locally, are very high, but cover only a small areas at any one time. Rainfall rates of several inches/hour commonly exist in their center. Thus the observed long-time loss of signal (> 35 db increase in attenuation for 32 minutes at 20.2 GHz and for 40 minutes at 27.5 GHz) is not surprising.

Figure I-4. presents data on the first thunderstorm of the season. It occurred while a weak weather front was passing through - thus is representative of a weather "event" in the transition from winter to summer climate conditions.

Figures I-5 and I-6 provide a composite of all weather "events" in the winter-to-summer climate transition. Dates of occurrence have been typed in. The small number of May events is explained by the fact that May 1994 was the driest May ever encountered (see Figure I-1).



WINTER WEATHER FRONT, 01/18/94

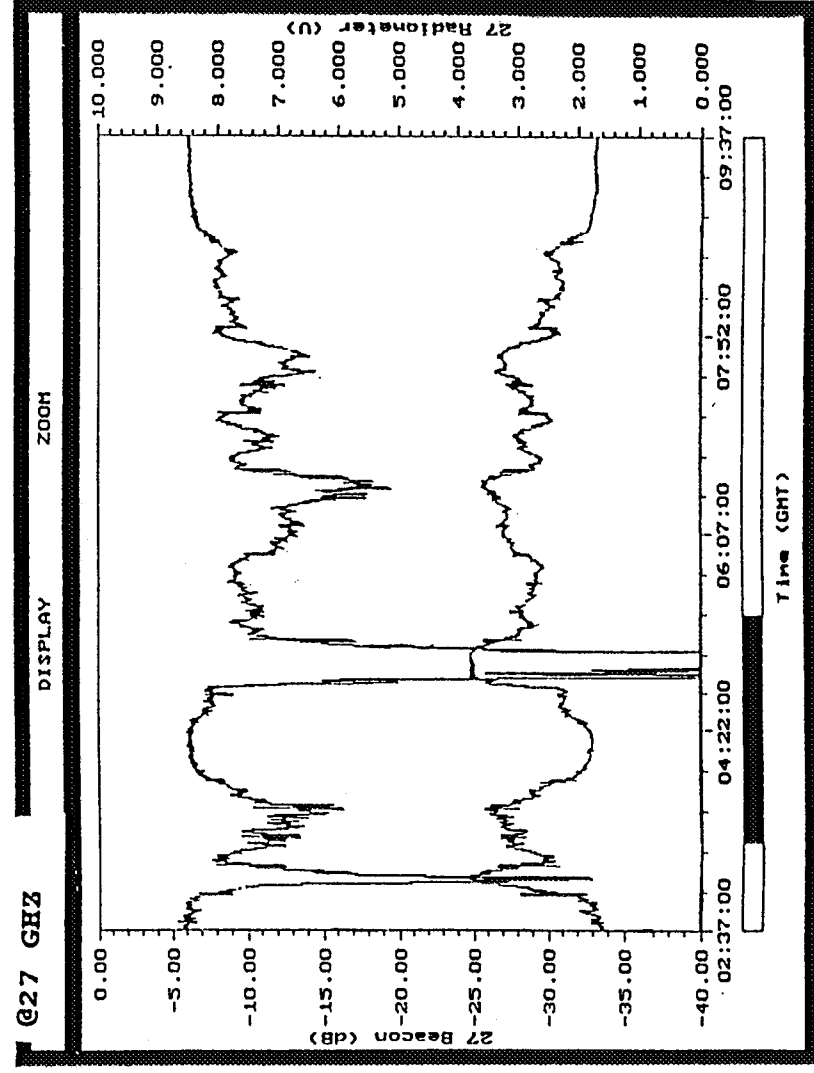


Figure I-2

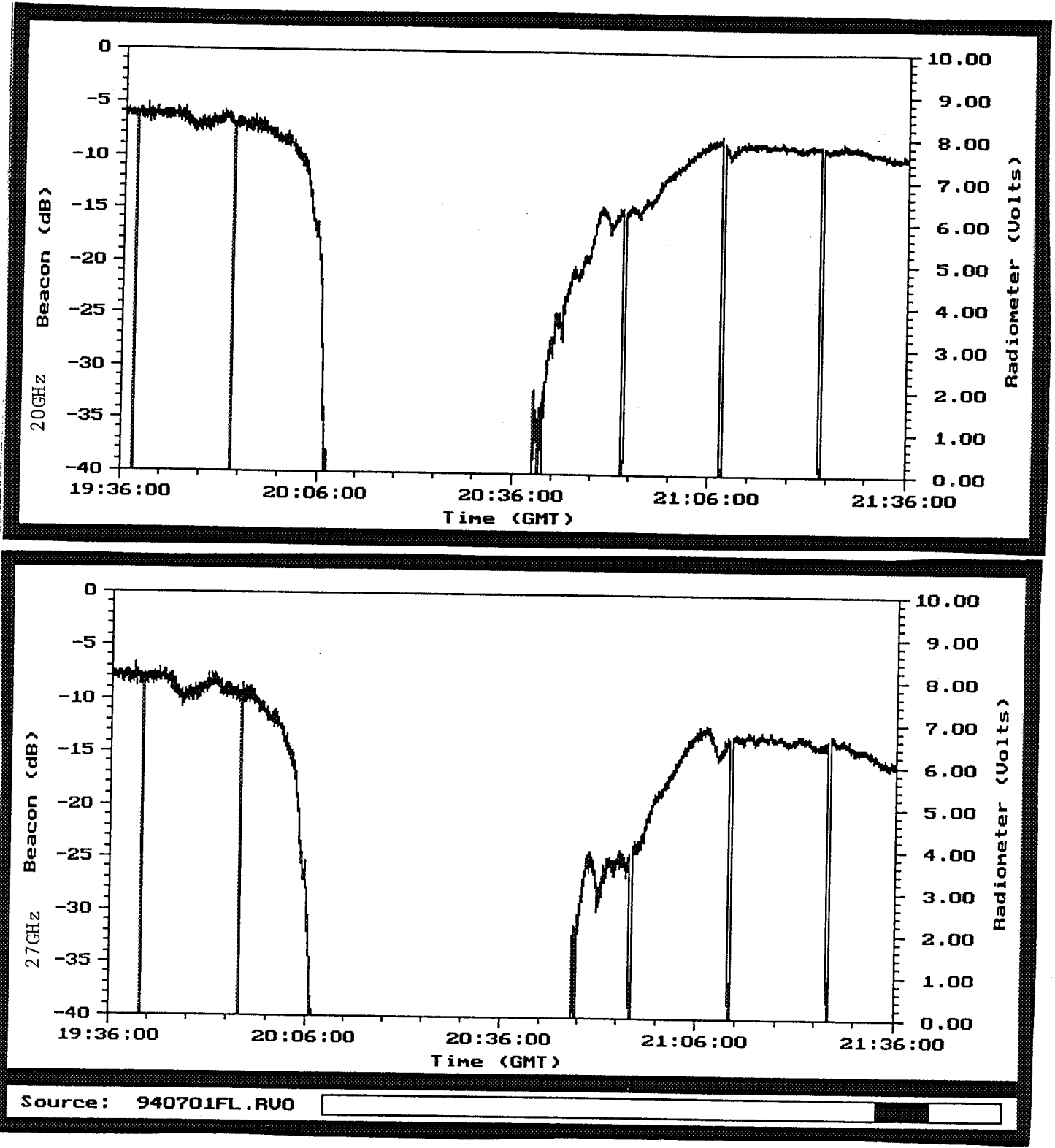
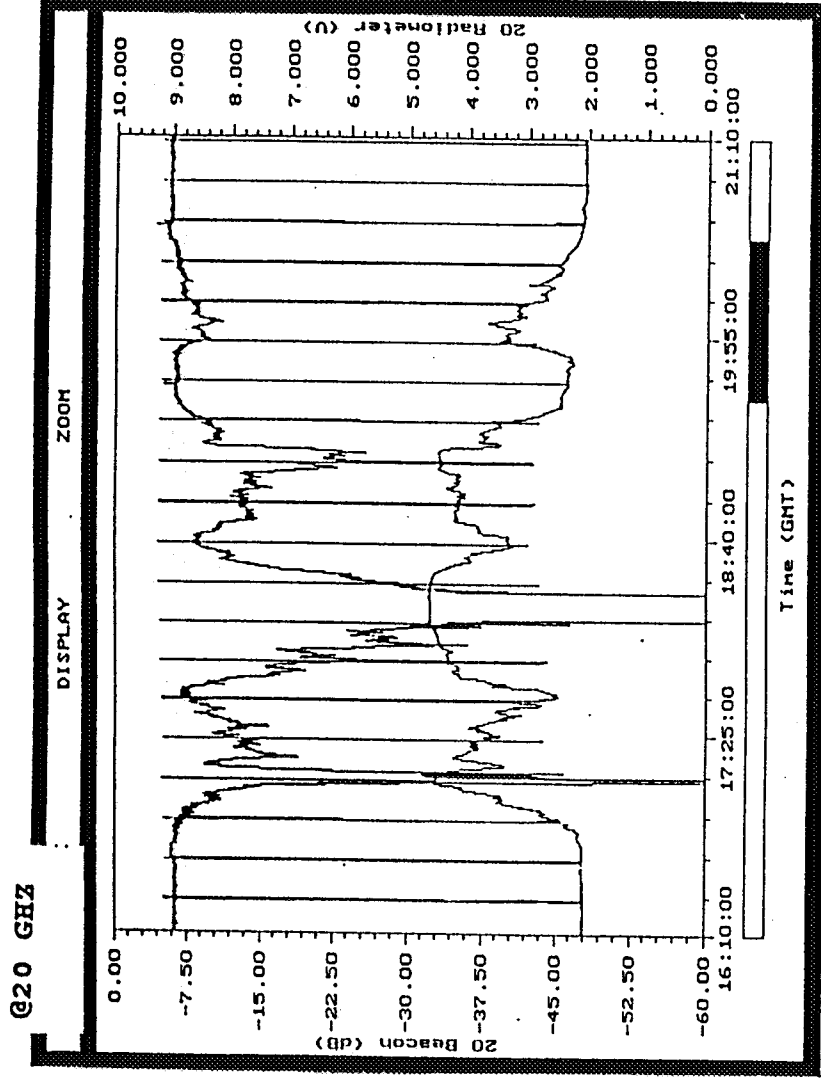


Figure I-3: SEVERE SUMMER THUNDERSTORM



FIRST 1994 THUNDERSTORM, (04/23)

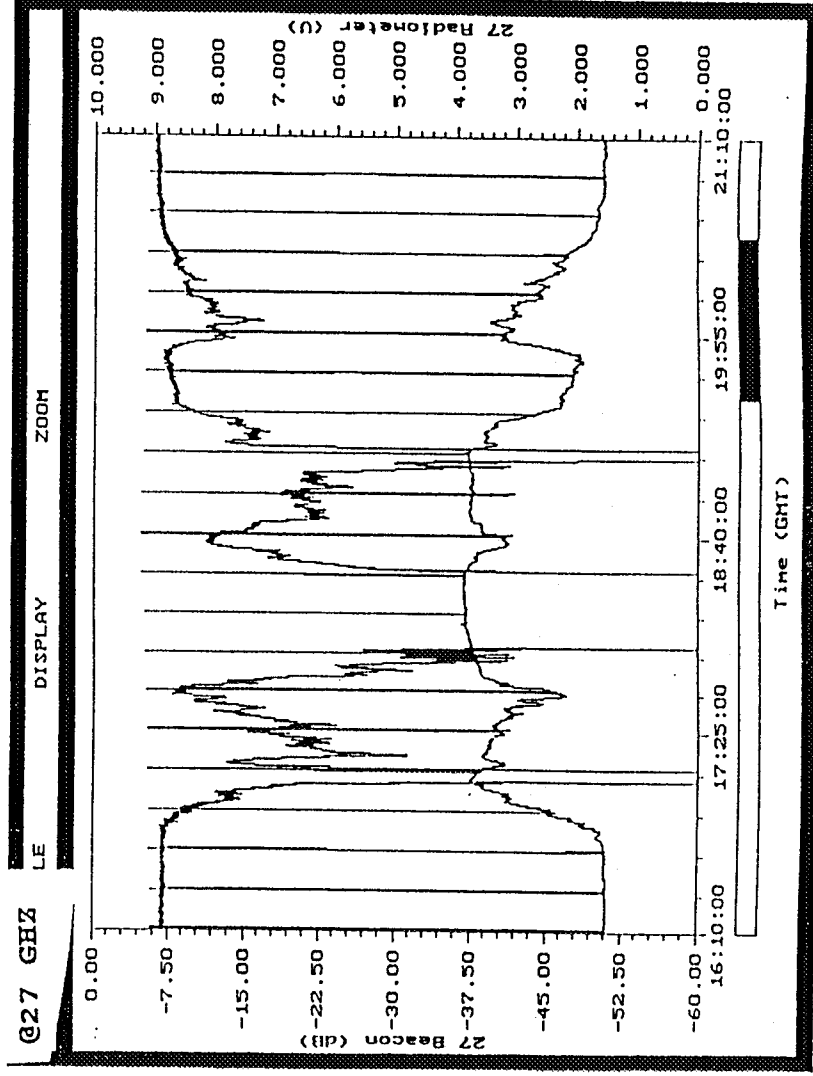


Figure I-4

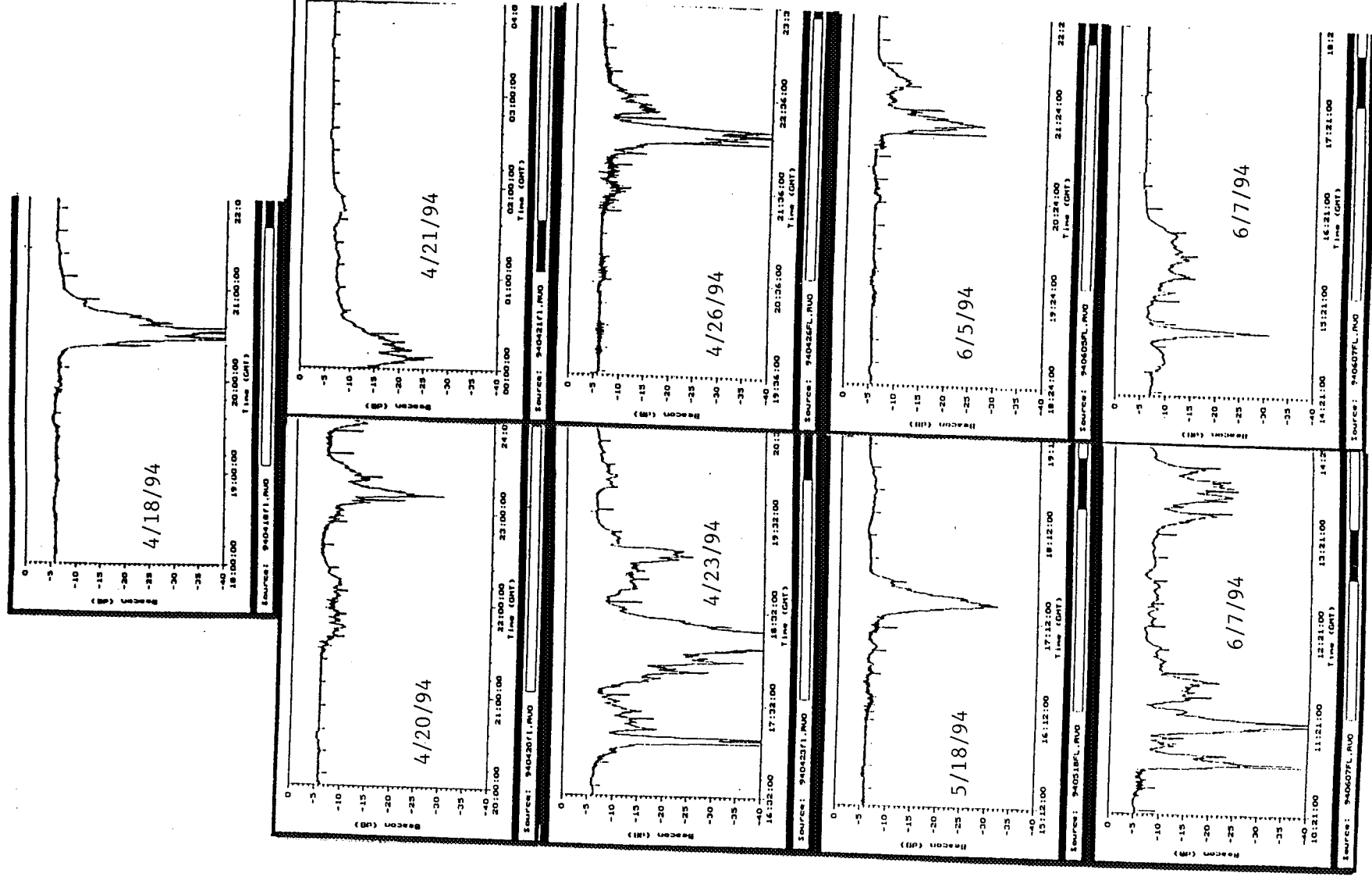


Figure I-5

**IMPACT ON 20 GHz SIGNALS BY
LOCAL RAINS AND THUNDERSTORMS, 04/18 TO 06/07**

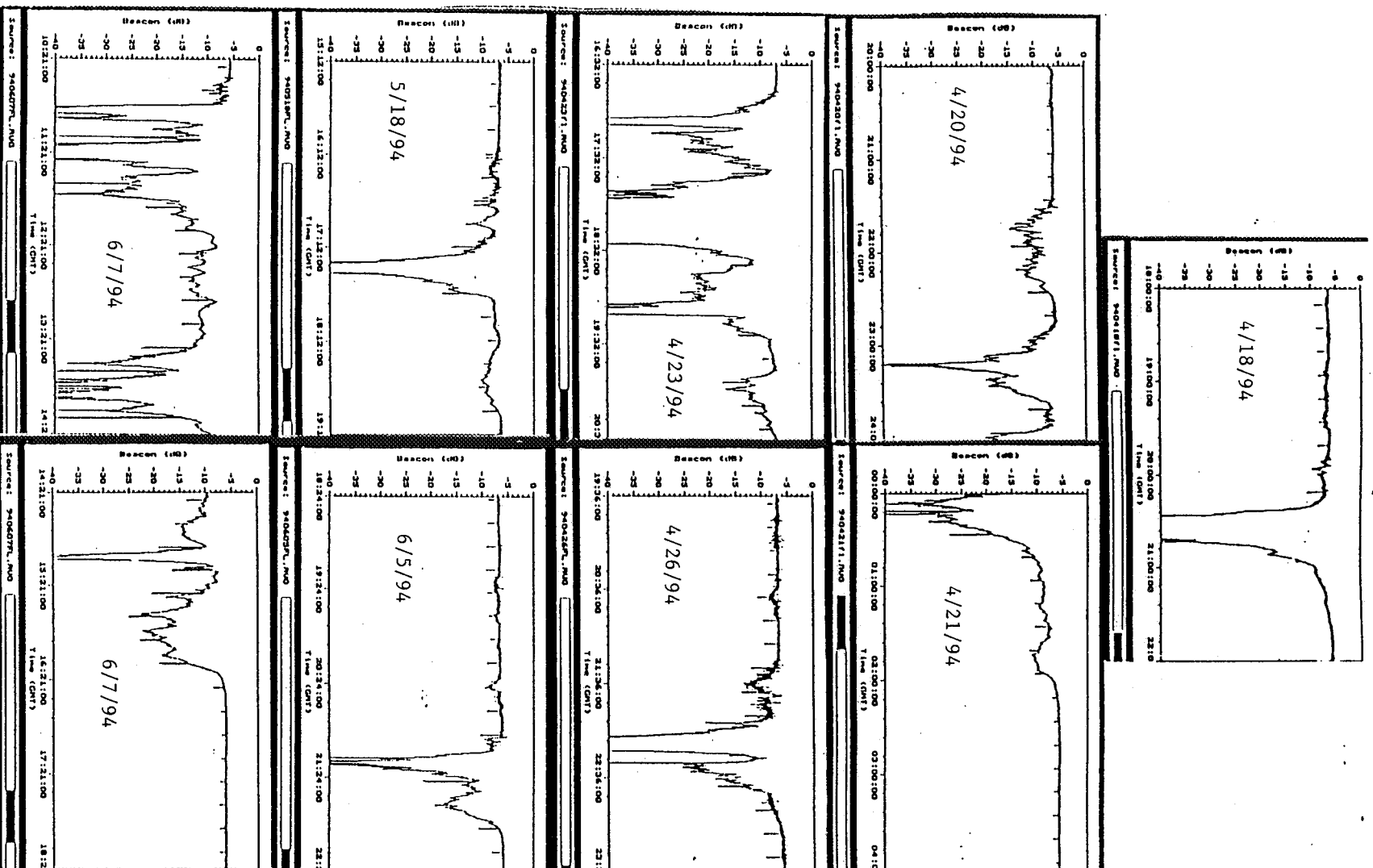


Figure I-6
 IMPACT ON 27 GHz SIGNALS BY
 LOCAL RAINS AND THUNDERSTORMS, 04/18 TO 06/07

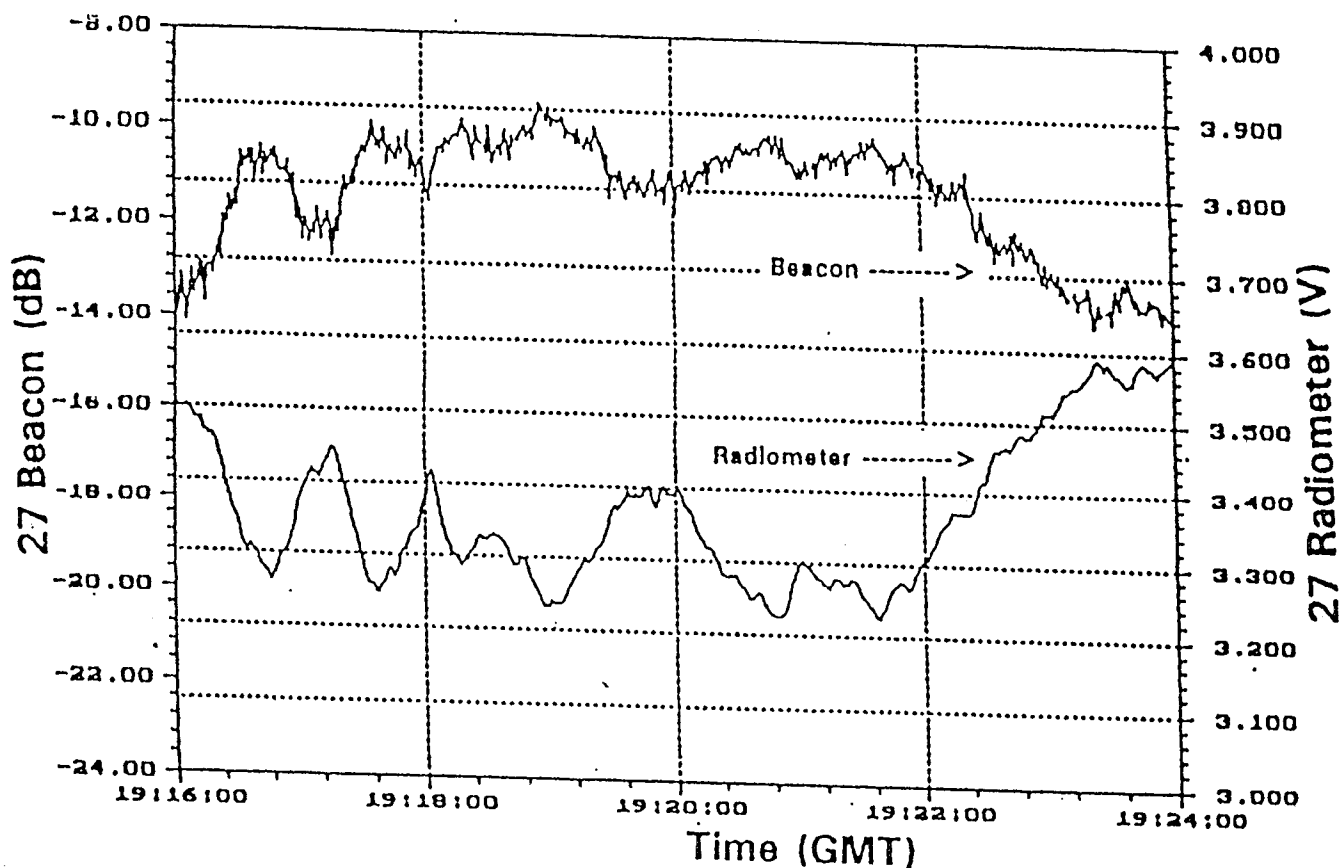
2. "Fast" Signal Variations Related:

The data presented here may on casual inspection be somewhat surprising, but actually confirms conclusions one would reach after a little thought.

Figure I-7 crushes any thought one might harbor that scintillation, being a type of random phenomena, shows no correlation between two independent signals at different frequencies. This scintillation-type data is presented on a time scale of 3 seconds = one small division. Extremely close correlation between the 20.2 and 27.5 GHz beacon signals is clearly visible. (Since this scintillation is weather induced, i.e., the signals travel through the same clouds, this is really not surprising.)

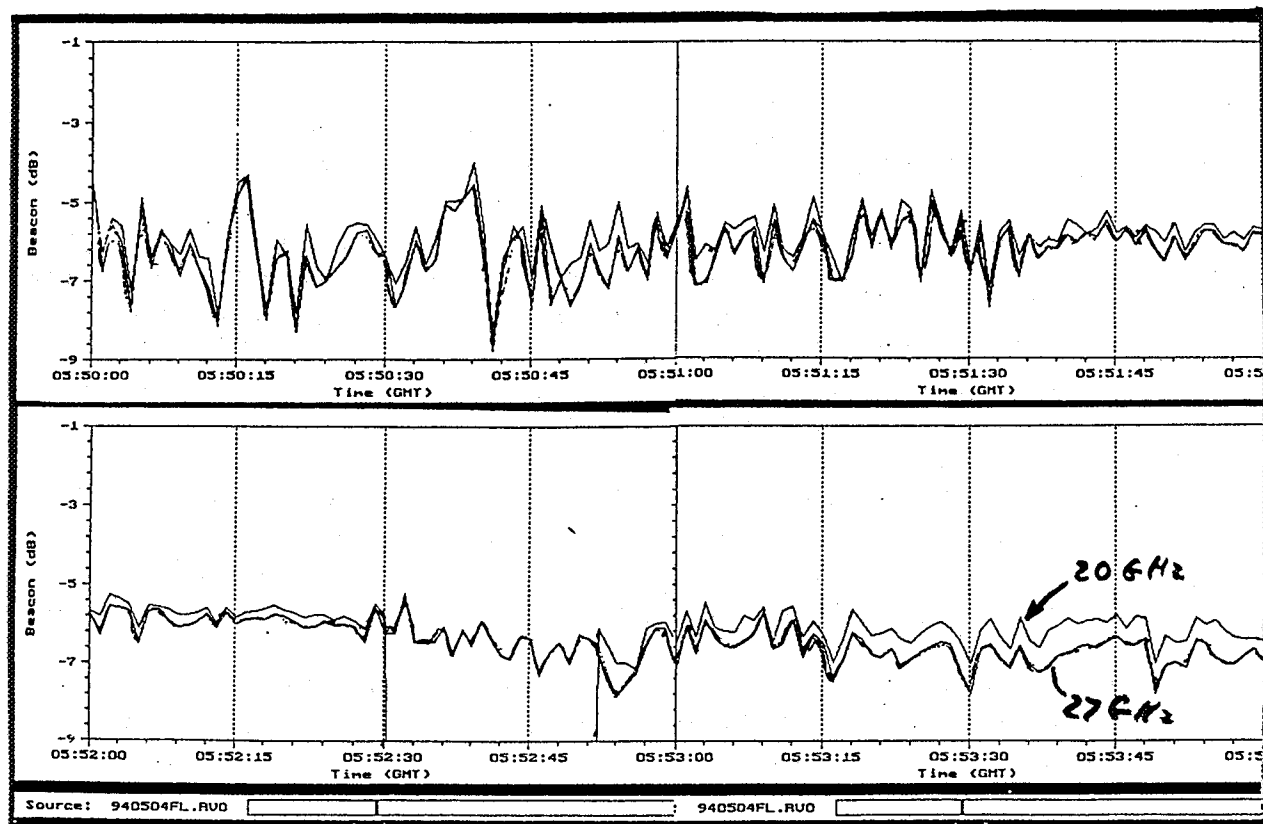
Figure I-8 spoils any illusion that propagation losses coincide with rainfall at the point of reception. A time delay of approx. 3 minutes between signal loss and heavy rainfall at the point of reception is clearly evident. In this case, heavy rainfall at a nearby location through which the beam passed was sufficient to cause loss of signal.

Figure I-9 confirms that close time-correlation exists between Beacon signal loss variations and radiometer output voltage (or sky temperature) variations. (Note that one small time division = 24 seconds.)



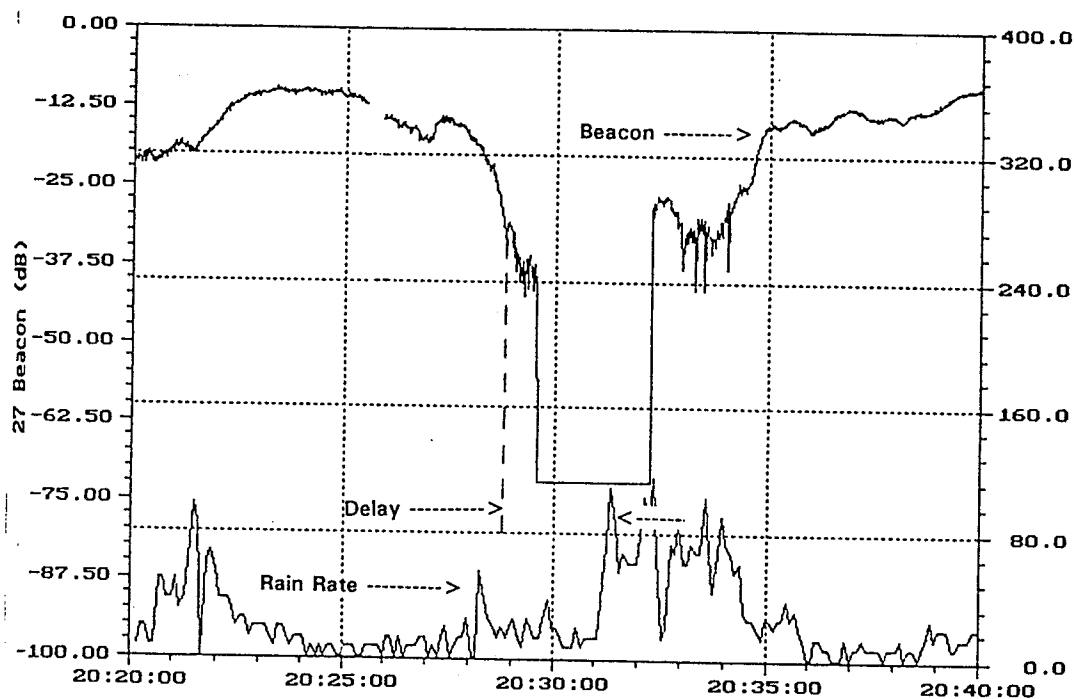
RADIOMETER/BEACON SIGNAL CORRELATION

Figure I-9



FOUR MINUTES OF 20 & 27 GHZ BEACON SIGNALS

Figure I-7



BEACON-SIGNAL/SITE-RAINFALL CORRELATION

Figure I-8

C. CURRENT "CHALLENGES"

1. Meteorological Instruments:

We are experiencing continuing problems in this area. Specifically:

a. Our Rain Gauge (As monitored on ACTSVIEW) rarely supplied information agreeing with "looking-out-the-window" data. It is very noisy, including off-scale readings, and often does not record rainfall or records rain when there is none. We are currently checking the complete set-up for the third time, including another laboratory calibration check of the rain gauge alone.

Any system-recorded rain data should be ignored. We are in the process of collecting rainfall information based on local data from other sources which we plan to compile and submit to the University of Texas' data center when completed.

b. The Humidity Gauge exhibited until very recently readings that made all data supplied suspect. (Example: readings well above 100% and step-function jumps in humidity which violate the laws of nature.) We finally traced the problem to the fact that the APT does not provide a dc voltage to the gauge in the range specified by its manufacturer. Adding a 6 volt battery in series with the APT-provided d.c. cleared up the problem and gives us temporary fix.

c. We believe that our wind velocity indication is consistently much lower than the actual wind velocity at its location. To-date other more urgent tasks have kept us from investigating this further.

d. If a need for uniform and systematic reporting of operational situations, such as outages, exists, it may be desirable to establish a "procedure" and "format" for reporting such information.

2. Power Failures:

We installed a backup system to the NASA-provided UPS to handle power outages up to a day or longer. The system works fine whenever it is tested. It provides power to our equipment when the building or campus is without power (as has happened twice). But --- data flow from the outside receiver enclosure to the inside lab computer is lost. We suspect major transients are the culprit -- unfortunately we cannot shut off the college's or campus' power to test details of this theory.

3. System "Crashes":

For months the system ran rather trouble-free. Then we began encountering "crashes". Observation that they always occurred at about the same time led to relating them to the sun moving into a position where it directly illuminated the fiber-optic input at the back of the PC. Black plastic blocking the sunlight provided a simple cure for this very high frequency EMI.

3. Water on the Antenna Dish:

We delayed applying the recommended hydrophobic paint to take data on the effect of dew (which frequently occurs in the spring) on attenuation data. Information has been collected and a brief report will be issued.

4. Enclosure Temperatures:

We are concerned about possibly significant temperature gradients between components in the temperature-controlled enclosures, measured at the same time. (A typical recent day shows at any one time the following differences: 27 vs. 20 Reference Loads: +1.94°, 27 vs. 20 IF's: -5.79°, 27 vs. 20 Radiometers: -2.34°, Front End Plate vs. Air: +2.84°, Front End Plate vs. 27 GHz Ref. Load: -2.50°.)

Similarly, we are concerned about the min/max daily variations in components or assemblies, whose performance is likely to be temperature sensitive. Temperature variations in degree centigrade on a typical recent day were:

| | | | |
|--------------------------------|-------|-----------------------|------|
| Outside Temperature (for ref.) | 13.0° | Receiver Enclosure | 1.9° |
| 20 GHz Reference Load | 2.1° | 27 GHz Reference Load | 1.2° |
| 20 GHz Radiometer | 1.2° | 27 GHz Radiometer | 1.7° |
| 20 GHz I.F. | 3.8° | 27 GHz I.F. | 5.4° |
| Front End Plate | 0.5° | Front End Air | 4.6° |

5. New Doppler Radars:

The Tampa Weather Bureau is currently checking out its new long range NEXRAD radar. Installation of a shorter range Doppler radar, particularly devoted to detect severe weather cells, including windshear, at Tampa's airports, has commenced. Thus within a year there will be two modern Doppler radars "on the air" which will cover our ACTS beam, and concurrently provide new opportunities for more precisely assessing weather effects on mm propagation.

II. FLORIDA ATLANTIC UNIVERSITY

1. CDF's:

On the next page CDF data plots are presented. Figure 1 is a composite CDF of the 20 GHz and 27 GHz beacon attenuation data for the period December 1993 to February 1994. Figure 2 illustrates the corresponding radiometer CDF's. Subsequent data has been processed but not included due to unresolved questions in calibration. These must be resolved first, since this will impact some observations which exhibit higher attenuation values at 20 GHz than at 27 GHz.

2. SUN MOVEMENT:

A computer program has been written to trace the apparent sun movement across the terminal field of view and a graphical output is illustrated in Figure 3 (below). We would be happy to supply similar graphs for other sites.

SOLAR TRANSIT IN TERMINAL FOV

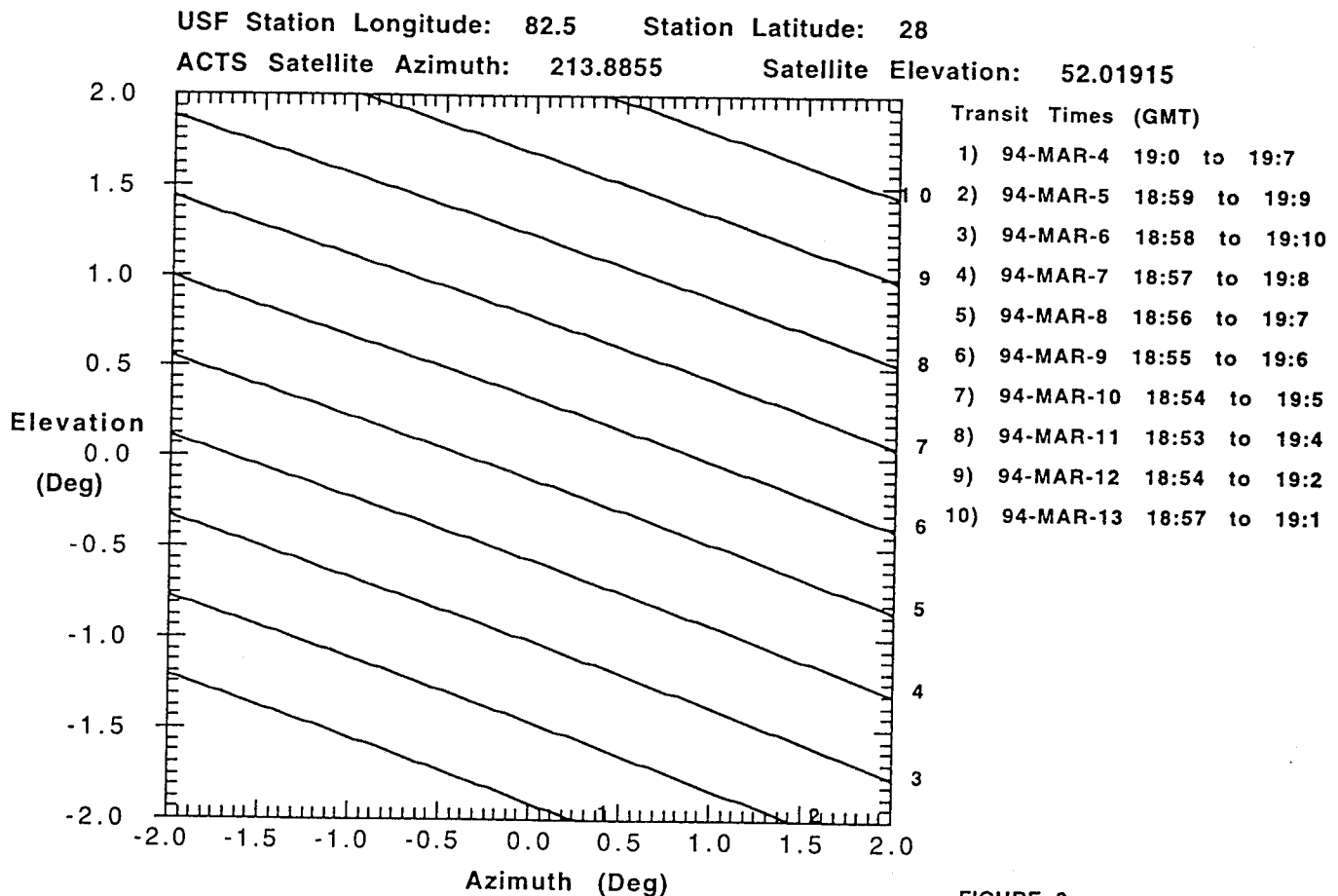
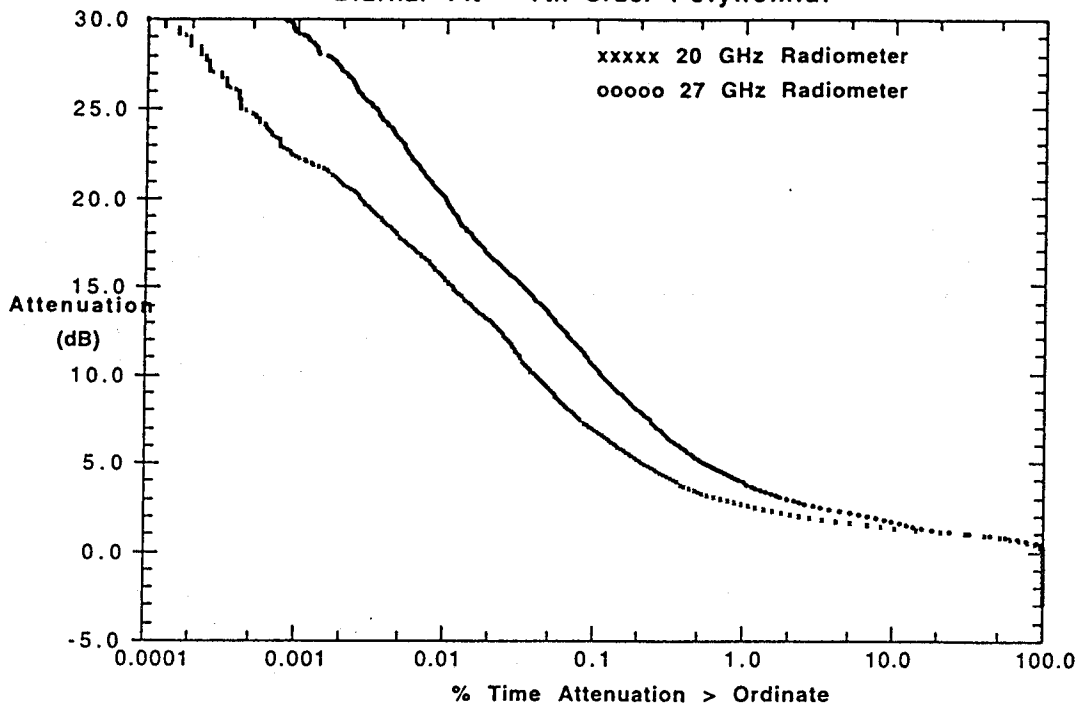


FIGURE 3

12/93 - 2/94 CUMULATIVE DISTRIBUTION

ACTS Propagation Terminal - Tampa, Florida

Diurnal Fit - 4th Order Polynomial



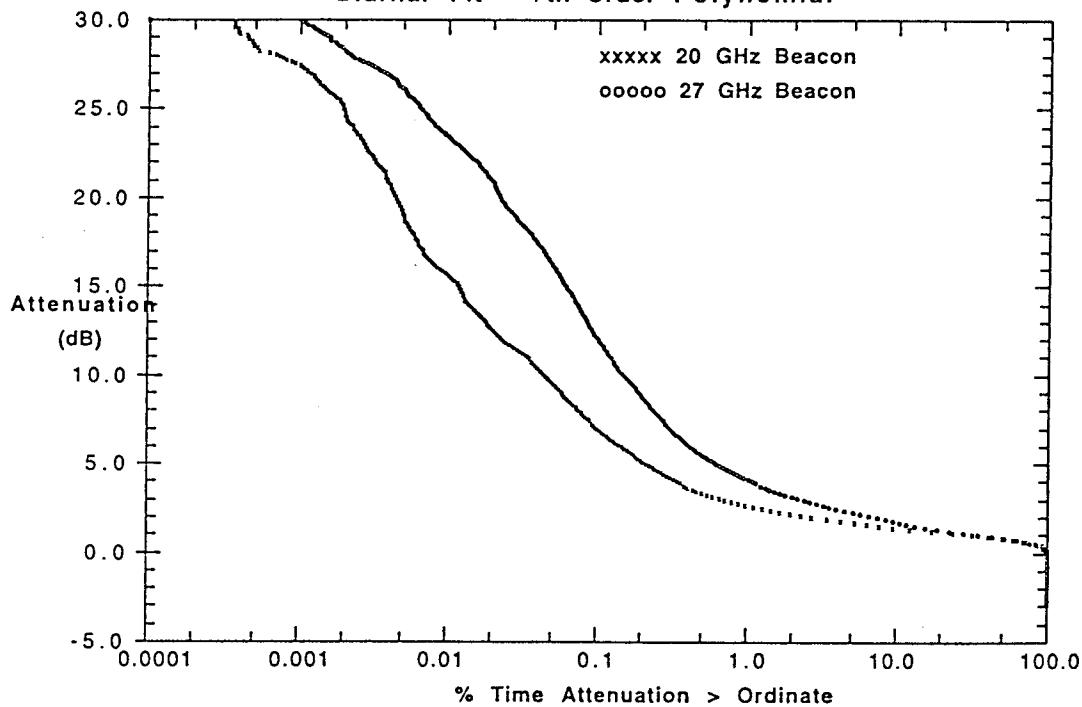
Data File: 93-94

FIGURE 2

12/93 - 2/94 CUMULATIVE DISTRIBUTION

ACTS Propagation Terminal - Tampa, Florida

Diurnal Fit - 4th Order Polynomial



Data File: 93-94

FIGURE 1

3. DIVERSITY EXPERIMENTS:

A series of diversity experiments are planned for later this year. Figures 4 and 5 below exhibit the rationale and the status of the receive-only transportable terminal. Initial measurements and calibration will occur adjacent to the ACTS terminal at USF in Tampa. Subsequent measurement sites will be in the range from 10 km to 30 km distant.

SITE DIVERSITY PROGRAM

- * GOAL
Diversity Measurements in a Sub-Tropical Weather Zone
- * PREVIOUS MEASUREMENTS
Tampa Triad: COMSTAR Beacon Experiments 1978-1979
19 GHz, Rainy Season Diversity
Sponsored by GTE
- * NASA ACTS Terminal Location
Campus of University of South Florida (USF)
Tampa, Florida (28° N, 82.5° W)
- * Possible Remote Locations
Within USF Campus - 2 km
Local School Areas 15 to 38 km

Figure 4

TRANSPORTABLE TERMINAL

- * Present Configuration
1.2 m Dish, Receive Only (RO) Terminal at 19 - 20 GHz
Downconvert to 3.3 GHz (LET IF) or 70 MHz
Record Signal Amplitude at ~1 Hz via HP 8563A Analyzer
- * Upgrades in Progress
Downconvert 70 MHz to Baseband
Digital I & Q Demodulation
Sustained Recording at 8kHz rate
- * Possible Additional Upgrades
Add Noise Diode for Calibration
Add 30 GHz Channel

Figure 5

4. By way of reference, Figure 6 (below) illustrates the achievable Signal/Noise ratio when using only the terminal feed horn on an ACTS CW in-band signal. Data is useful for anyone planning to do shadowing, multipath or building measurements using ACTS in-band signals.

19.914 GHz ACTS Feed Signal

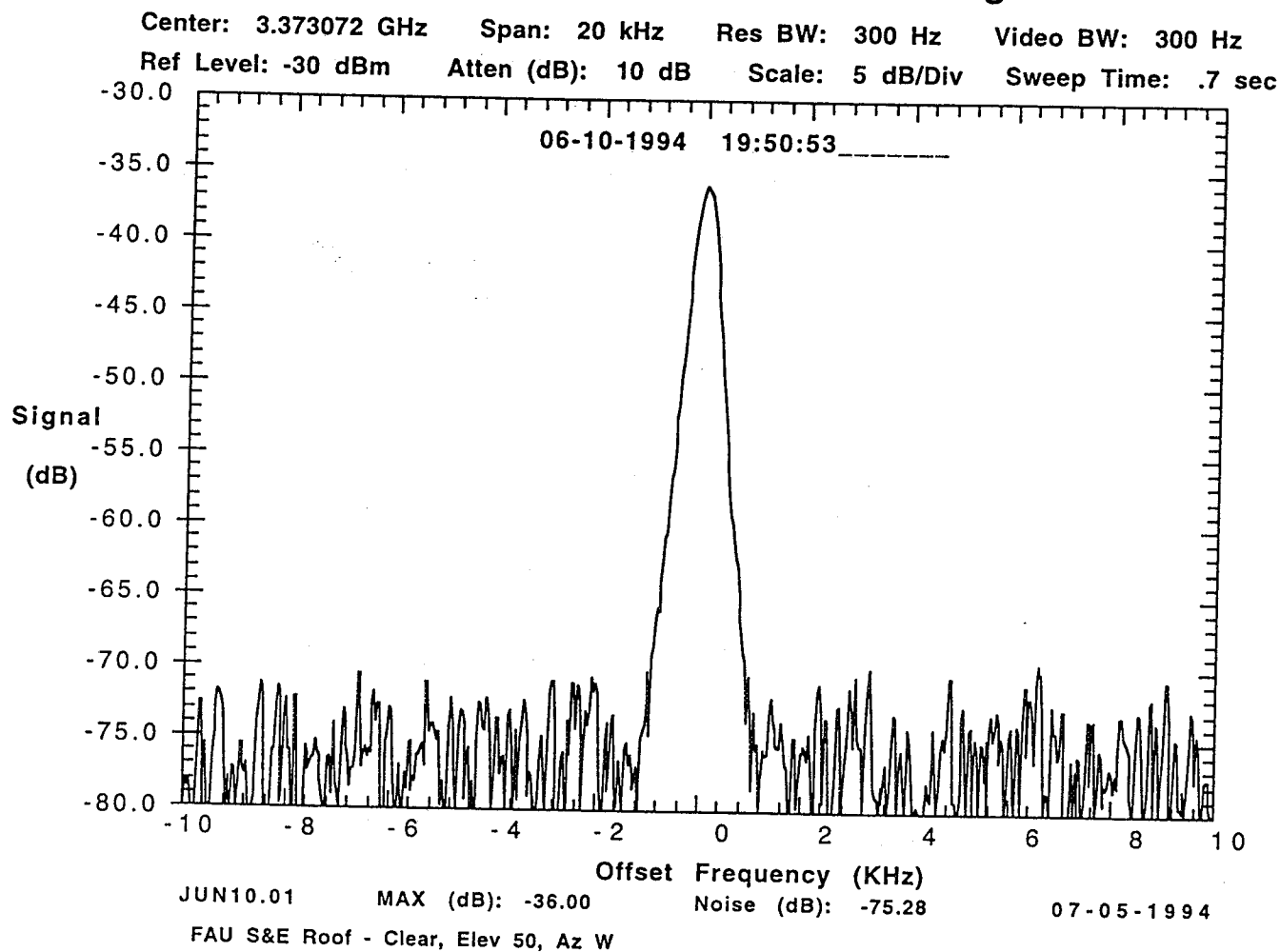


FIGURE 6

NEW MEXICO ACTS PROPAGATION TERMINAL STATUS REPORT

1 DECEMBER 1993 - 31 MAY 1994

Prepared by

**Stephen Horan and Glenn Feldhake
New Mexico State University
Department of Electrical and Computer Engineering
Las Cruces, NM 88003**

June 15, 1994

I. TERMINAL OPERATING TIME AND RAIN EVENT DAYS

NEW MEXICO ACTS FIRST QUARTER SUMMARY

| Month | Day | Las Cruces Sun News | NOAA | ACTS Terminal | NASA RainDance | DECEMBER | Days | Hr | Min | Sec | % |
|------------------|-----|------------------------|------|------------------|-------------------|--------------|------|------|-----|-----|--------|
| December | 12 | 0.05 | 0.04 | 0.01 | * | Up Time | 28 | 15 | 27 | 22 | 92.4% |
| | 13 | 0.00 | 0.02 | 0.00 | | Down Time | 2 | 8 | 32 | 38 | 7.6% |
| | 21 | 0.05 | 0.00 | 0.08 | * | Hot/Cold Cal | 3 | 17 | | | |
| | 22 | 0.24 | 0.32 | 0.35 | * | Air Temp | 10.9 | 18.4 | | | |
| | 23 | 0.01 | 0.00 | 0.00 | | | | | | | |
| | 29 | 0.32 | 0.10 | 0.00 | | JANUARY | Days | Hr | Min | Sec | % |
| | 30 | 0.03 | 0.29 | 0.00 | | Up Time | 31 | 0 | 0 | 0 | 100.0% |
| TOTAL RAIN ACCUM | | 0.70 | 0.77 | 0.44 | N/A | Down Time | 0 | 0 | 0 | 0 | 0.0% |

| Month | Day | Las Cruces Sun News | NOAA | ACTS Terminal | NASA RainDance | Hot/Cold Cal | Days | Hr | Min | Sec | % |
|------------------|-----|------------------------|------|------------------|-------------------|--------------|------|------|-----|-----|-------|
| January | 29 | 0.04 | 0.05 | 0.85 | | Air Temp | 7 | 21 | | | |
| | 30 | 1.78 | 0.00 | 0.00 | | | 6.6 | 22.0 | | | |
| | 31 | 0.00 | 0.04 | 0.00 | | FEBRUARY | Days | Hr | Min | Sec | % |
| TOTAL RAIN ACCUM | | 1.82 | 0.09 | 0.85 | 0.00 | Up Time | 24 | 9 | 59 | 2 | 87.2% |
| | | | | | | Down Time | 3 | 14 | 0 | 58 | 12.8% |

| Month | Day | Las Cruces Sun News | NOAA | ACTS Terminal | NASA RainDance | Hot/Cold Cal | Days | Hr | Min | Sec | % |
|------------------|-----|------------------------|------|------------------|-------------------|--------------|------|------|-----|-----|--------|
| February | 8 | 0.12 | 0.00 | 0.00 | * | Air Temp | 4 | 18 | | | |
| | 9 | 0.05 | 0.17 | 0.00 | | | 14.1 | 19.2 | | | |
| TOTAL RAIN ACCUM | | 0.17 | 0.17 | 0.00 | N/A | TOTAL | Days | Hr | Min | Sec | % |
| | | | | | | Up Time | 84 | 1 | 26 | 24 | 93.40% |
| | | | | | | Down Time | 5 | 22 | 33 | 36 | 6.60% |

* Represents Days NASA Rain Dance Data Indicates a Precipitation Event Occured. Accumulation and Rate Data were Not Provided.

NEW MEXICO ACTS SECOND QUARTER SUMMARY

| Month | Day | Las Cruces Sun News | NOAA | ACTS Terminal | NASA Rain Dance |
|------------------|-----|------------------------|-------|------------------|--------------------|
| March | 8 | 0.02 | 0.01 | 0.00 | * |
| | 14 | 0.15 | 0.12 | 0.79 | * |
| | 20 | 0.00 | trace | 0.00 | |
| TOTAL RAIN ACCUM | | 0.17 | 0.13 | 0.79 | N/A |

| MARCH | Days | Hr | Min | Sec | % |
|-----------|------|----|-----|-----|----------|
| Up Time | 30 | | 0 | 0 | 0 96.77% |
| Down Time | 1 | | 0 | 0 | 0 3.23% |

| Month | Day | Las Cruces Sun News | NOAA | ACTS Terminal | NASA Rain Dance |
|------------------|-----|------------------------|------|------------------|--------------------|
| April | 20 | 0.00 | 0.00 | 0.00 | * |
| | 21 | 0.07 | 0.07 | 0.00 | * |
| | 22 | 0.10 | 0.00 | 0.00 | |
| | 23 | 0.16 | 0.27 | 0.00 | * |
| | 24 | 0.00 | 0.03 | 0.00 | |
| TOTAL RAIN ACCUM | | 0.33 | 0.37 | 0.00 | N/A |

| APRIL | Days | Hr | Min | Sec | % |
|-----------|------|----|-----|-----|-----------|
| Up Time | 30 | | 0 | 0 | 0 100.00% |
| Down Time | 0 | | 0 | 0 | 0 0.00% |

| Month | Day | Las Cruces Sun News | NOAA | ACTS Terminal | NASA Rain Dance |
|------------------|-----|------------------------|------|------------------|--------------------|
| May | 8 | 0.00 | 0.01 | 0.00 | N/A |
| | 21 | 0.02 | 0.00 | 0.00 | N/A |
| | 22 | 0.00 | 0.01 | 0.00 | N/A |
| | 23 | 0.30 | 0.29 | 0.00 | N/A |
| | 24 | 0.00 | 0.04 | 0.00 | N/A |
| | 25 | 0.03 | 0.16 | 0.00 | N/A |
| | 26 | 0.15 | 0.00 | 0.00 | N/A |
| TOTAL RAIN ACCUM | | 0.50 | 0.51 | 0.00 | N/A |

| MAY | Days | Hr | Min | Sec | % |
|-----------|------|----|-----|-----|-----------|
| Up Time | 31 | | 0 | 0 | 0 100.00% |
| Down Time | 0 | | 0 | 0 | 0 0.00% |

| TOTAL | Days | Hr | Min | Sec | % |
|-----------|------|----|-----|-----|----------|
| Up Time | 91 | | 0 | 0 | 0 98.91% |
| Down Time | 1 | | 0 | 0 | 0 1.09% |

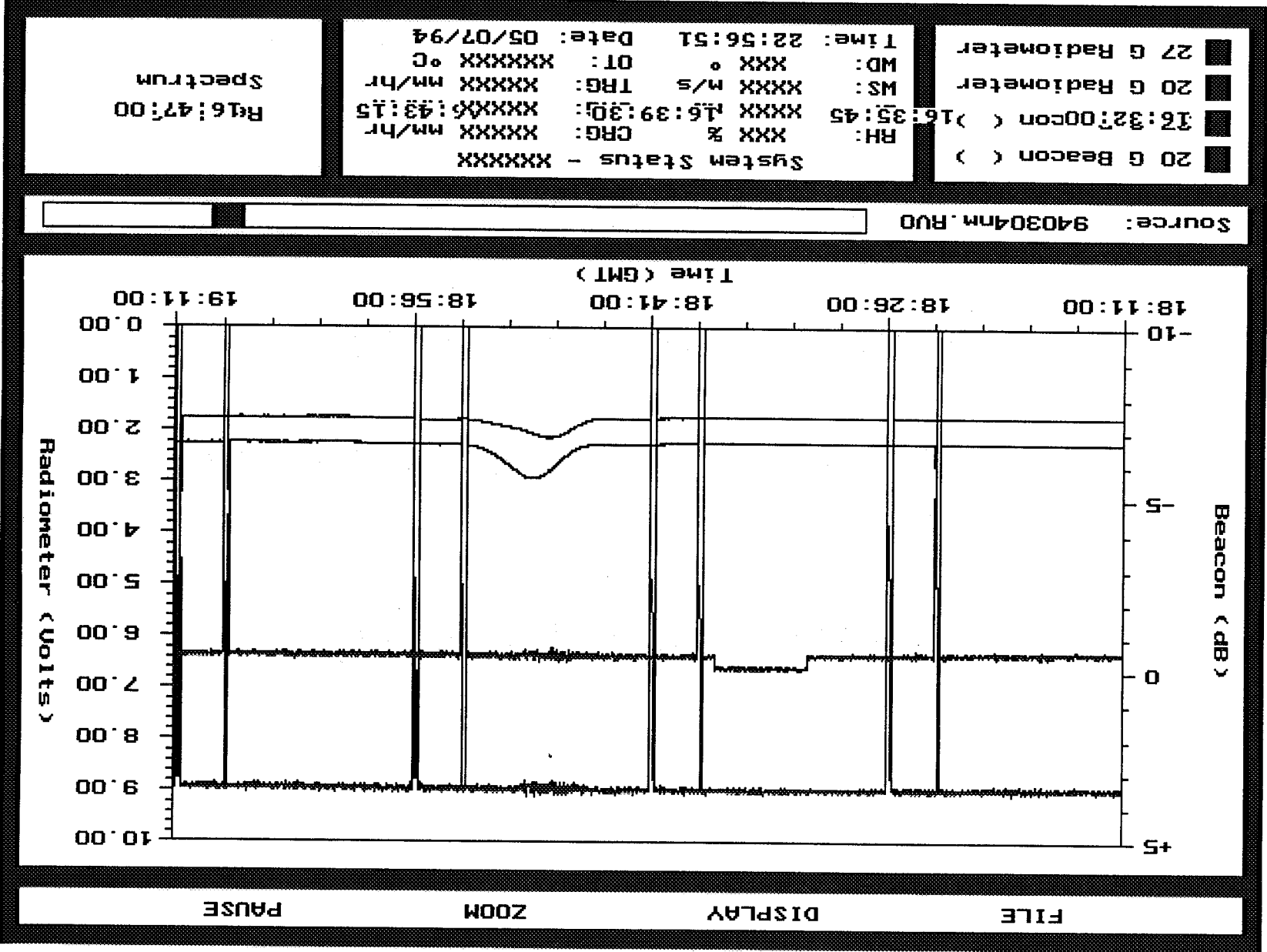
* Represents Days NASA Rain Dance Data Indicates a Precipitation Event Occured. Accumulation and Rate Data were Not Provided.

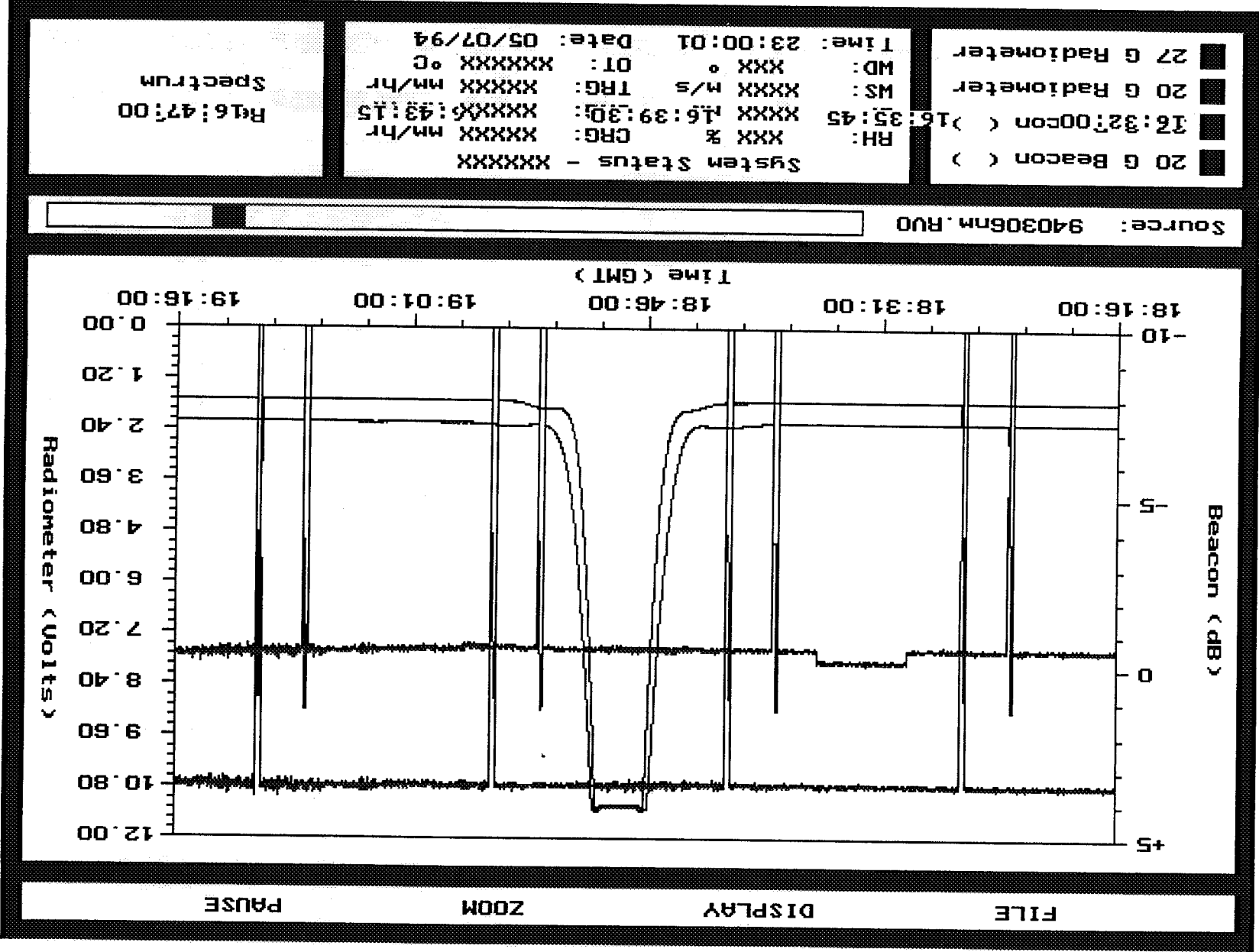
Up and Down Times are based on processable data
RV0 files may be present with unprocessable data.

II. SUN TRANSIENT EVENTS

Daily events on March 3 through March 9, 1994

- beacons did not have maximum noise at the same time in each channel!
- radiometer saturated on one day



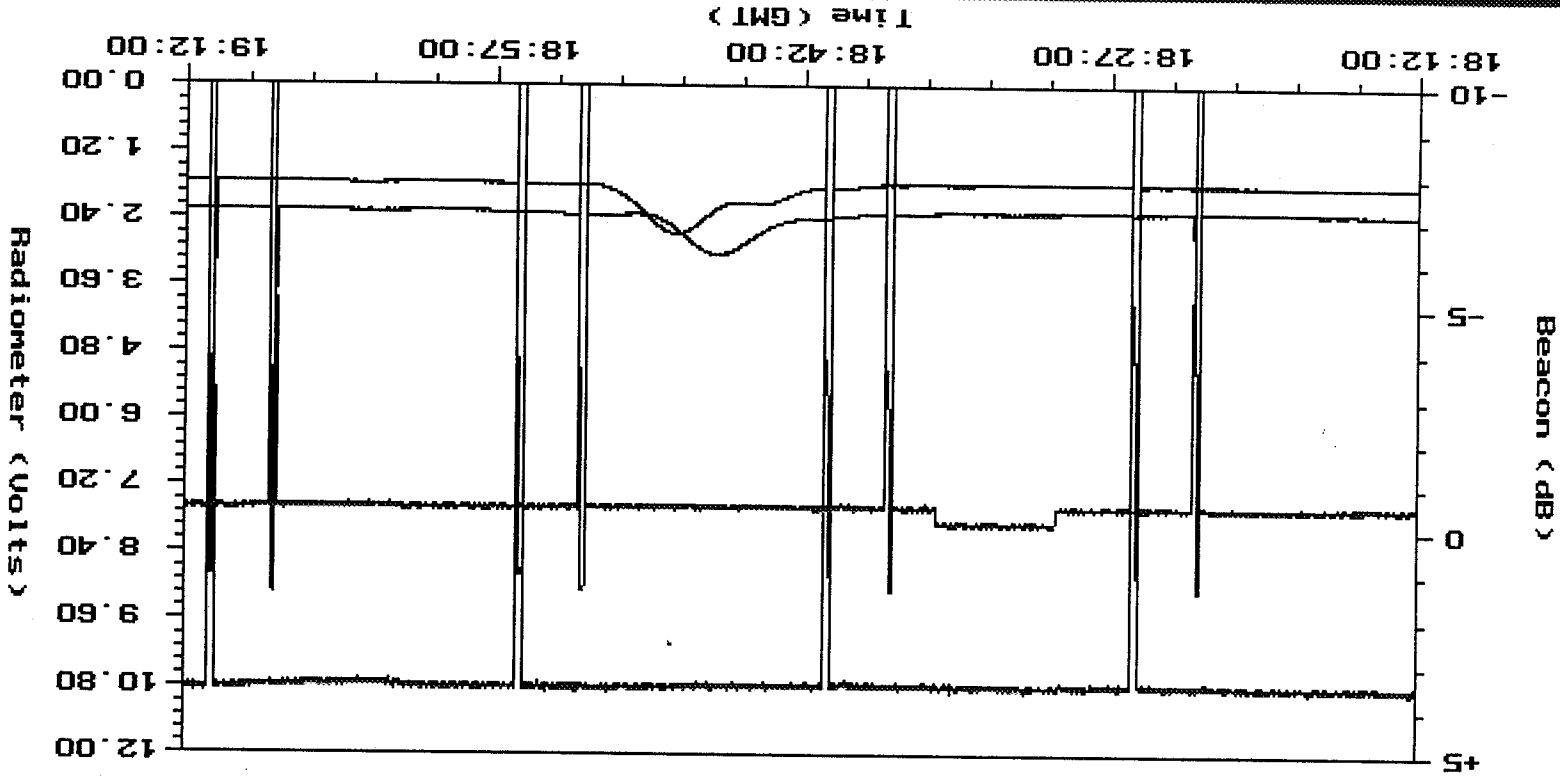


20 G Beacon ()
 16:32:00con ()16:35:45
 20 G Radiometer
 27 G Radiometer

System Status - XXXXXX
 RH: XXX % CRG: XXXXX mm/hr
 MS: XXXX m/s TRG: XXXXX mm/hr
 MD: XXX ° OT: XXXXXX °C
 Time: 23:03:14 Date: 05/07/94

Rt6:47:00
 Spectrum

Source: 940309nm.RU0

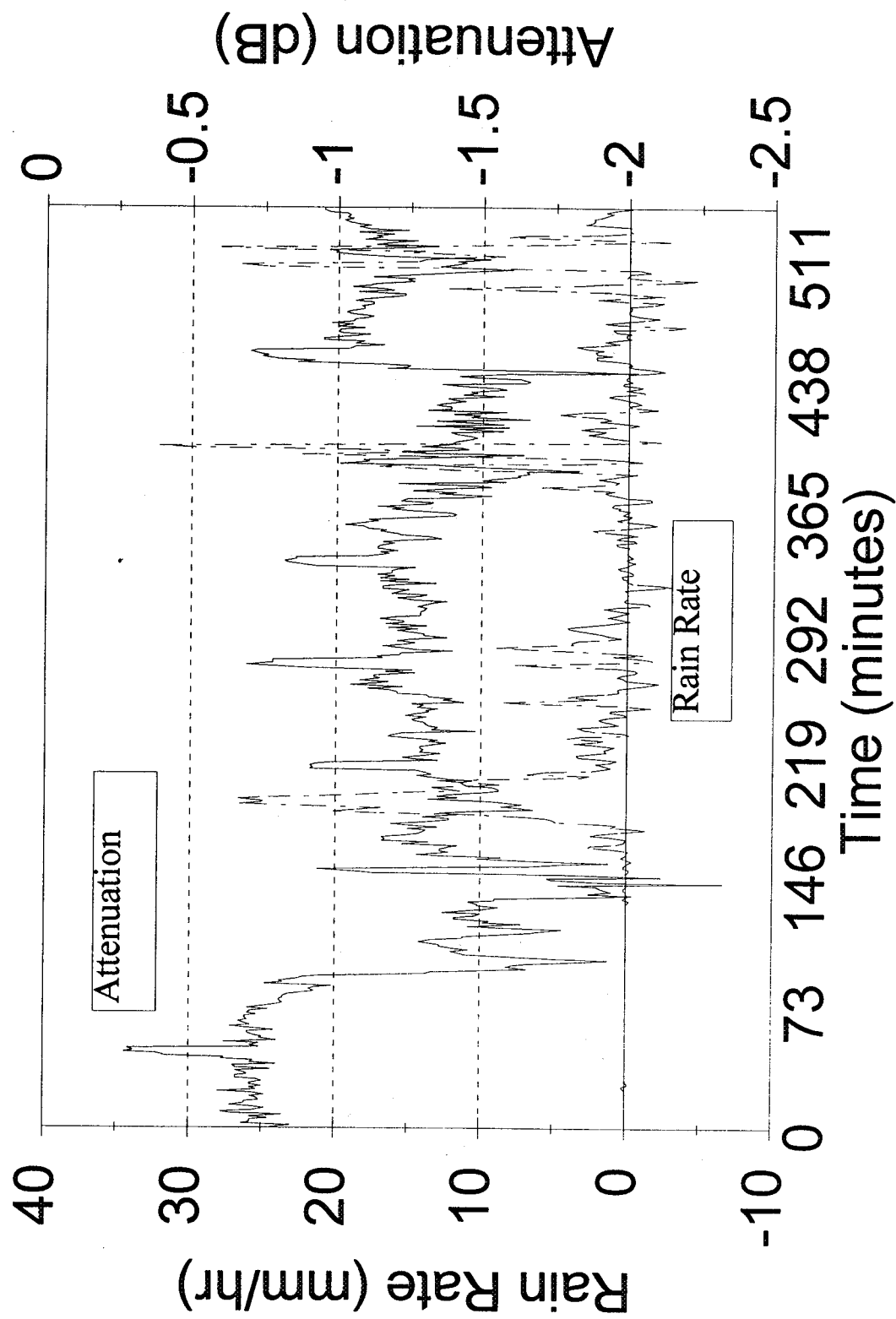


FILE DISPLAY ZOOM PAUSE

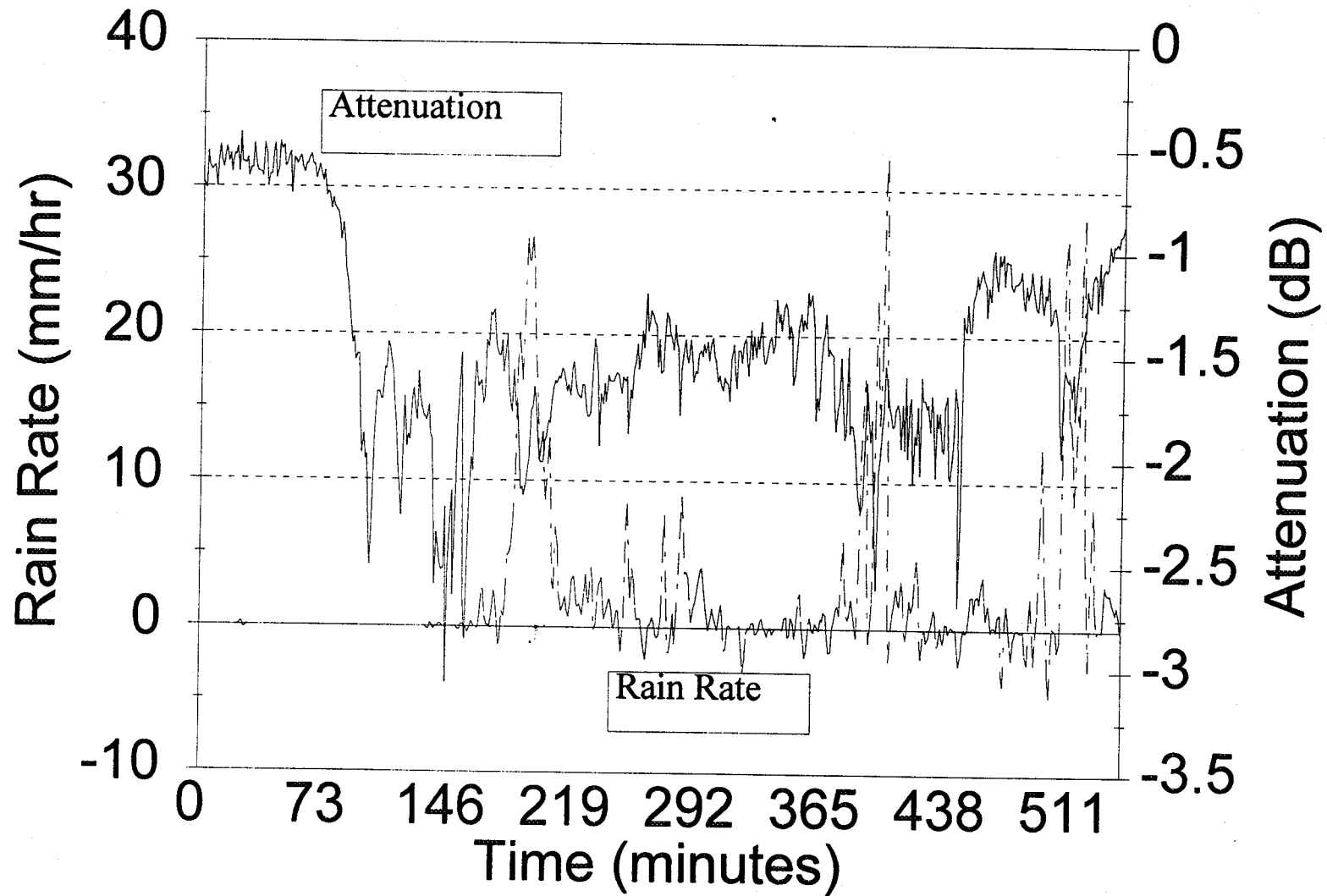
III. RAIN RATE MEASUREMENTS

- Rain gauge did not give reliable results this reporting period
- Tried 2-minute smoothing and numerical fitting for rain rate
- Only one day found with reasonable results - other days the rain reporting did not match fades

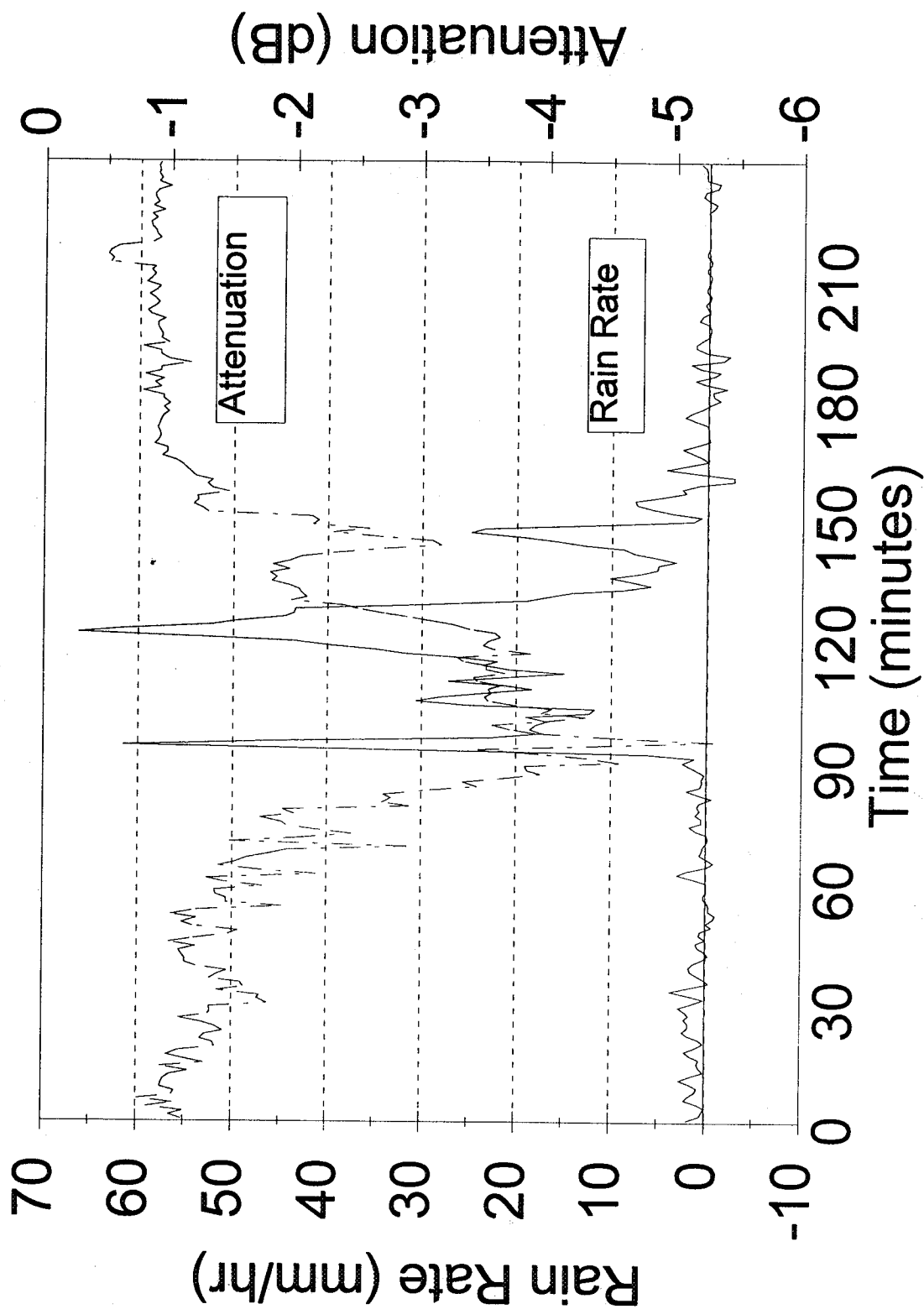
3-14-94 20 GHZ

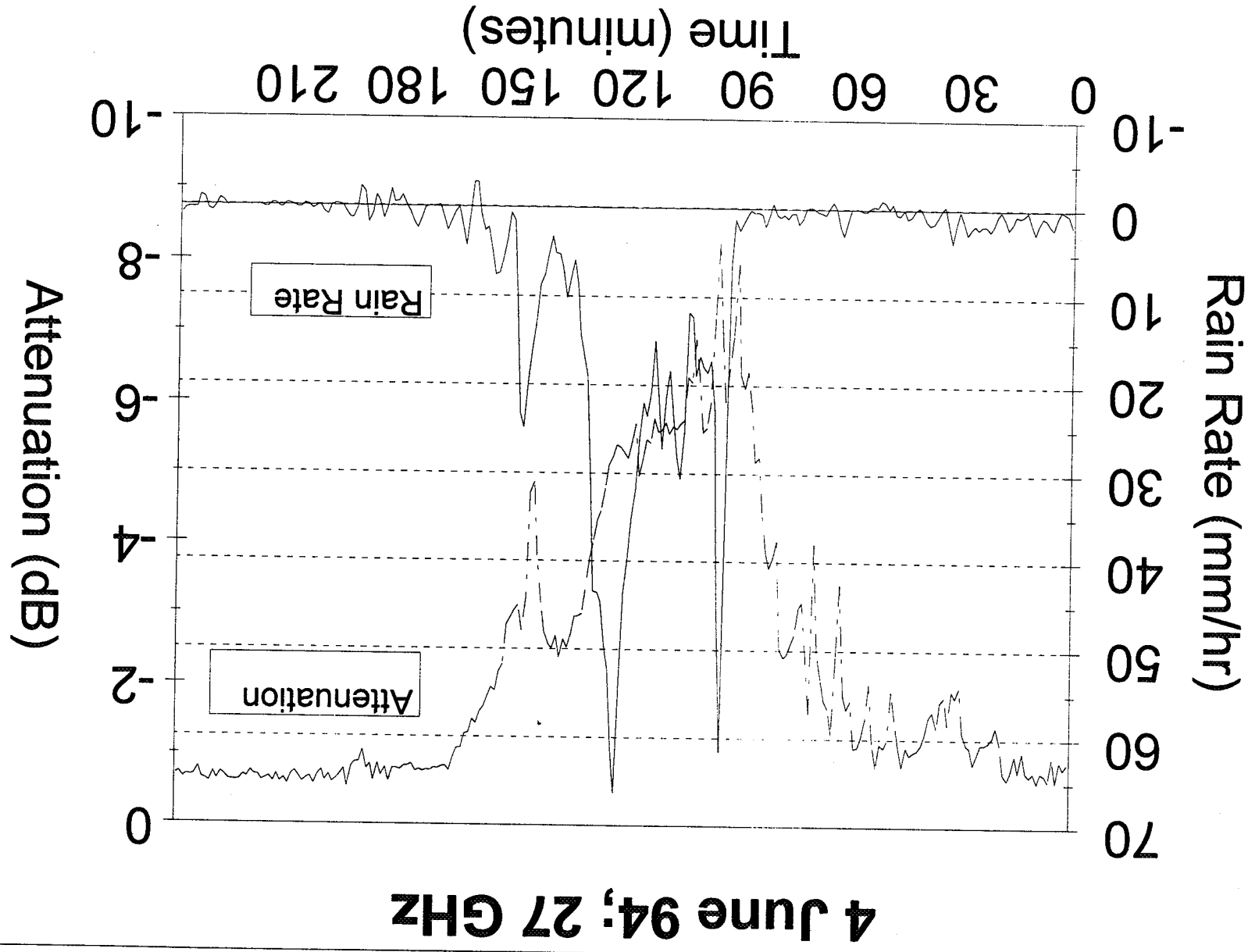


3-14-94 27 GHz



4 June 94; 20 GHz





Stanford Telecommunications / New Mexico State University

**ACTS PROPAGATION MEASUREMENTS
PROGRAM**

Louis J. Ippolito

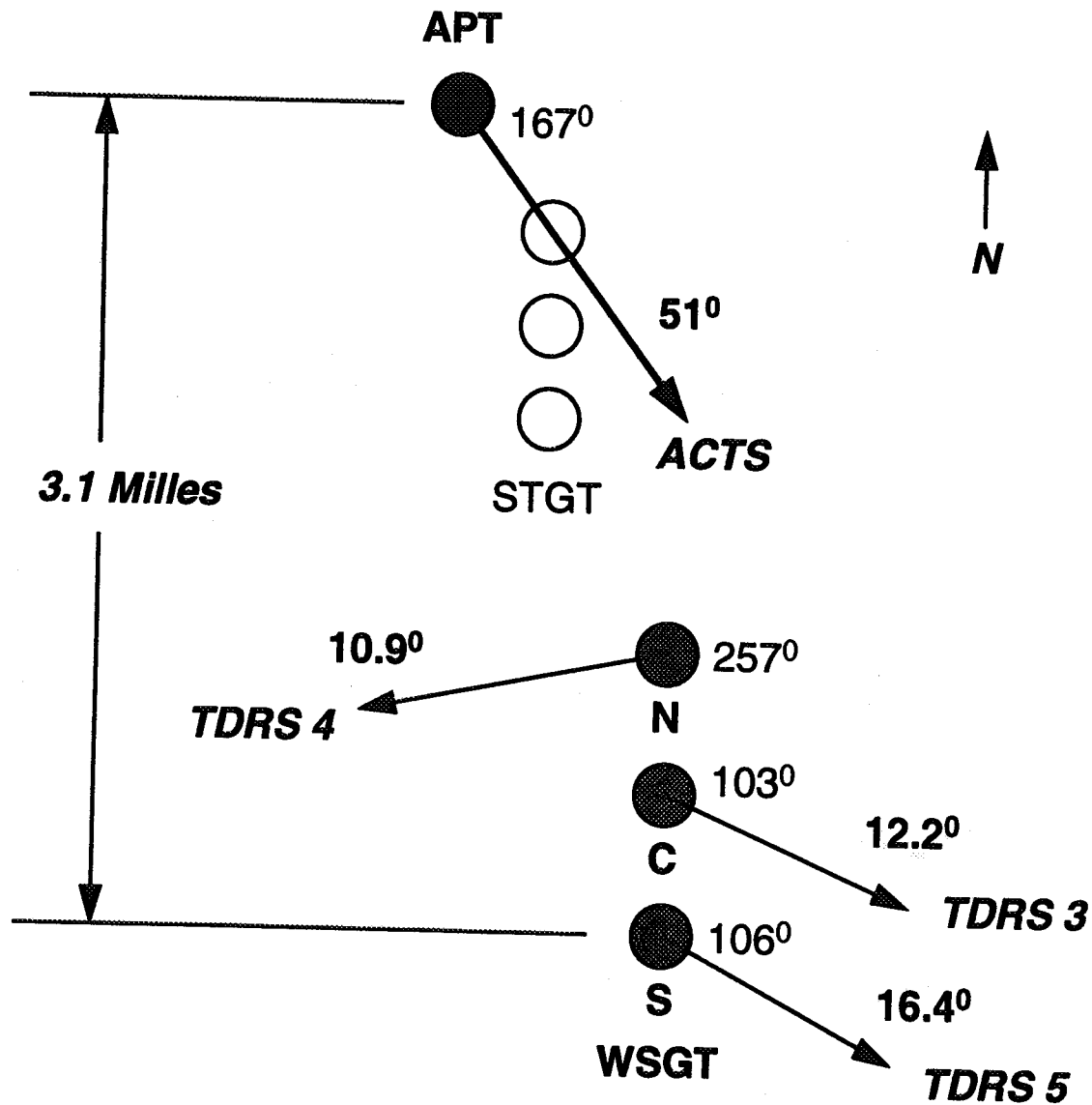
Data Analysis Summary

**NAPEX XVIII
NASA PROPAGATION EXPERIMENTERS MEETING
and
ACTS PROPAGATION STUDIES WORKSHOP
Vancouver, B.C.
June 16, 1994**

MEASUREMENTS

- ☐ ACTS PROPAGATION TERMINAL (APT) AT STGT
 - ELEVATION ANGLE: 51° TO ACTS
 -
- ☐ ANCILLARY MEASUREMENTS WITH TDRS
 - 13.5 GHz SPACE-TO-GROUND LINK (SGL) FADE SUMMARIES FOR 3 ANTENNA SYSTEMS AT WSGT (RAINDANCE)
 - ELEVATION ANGLES RANGE FROM 7° TO 18° FOR TDRS CONSTELLATION

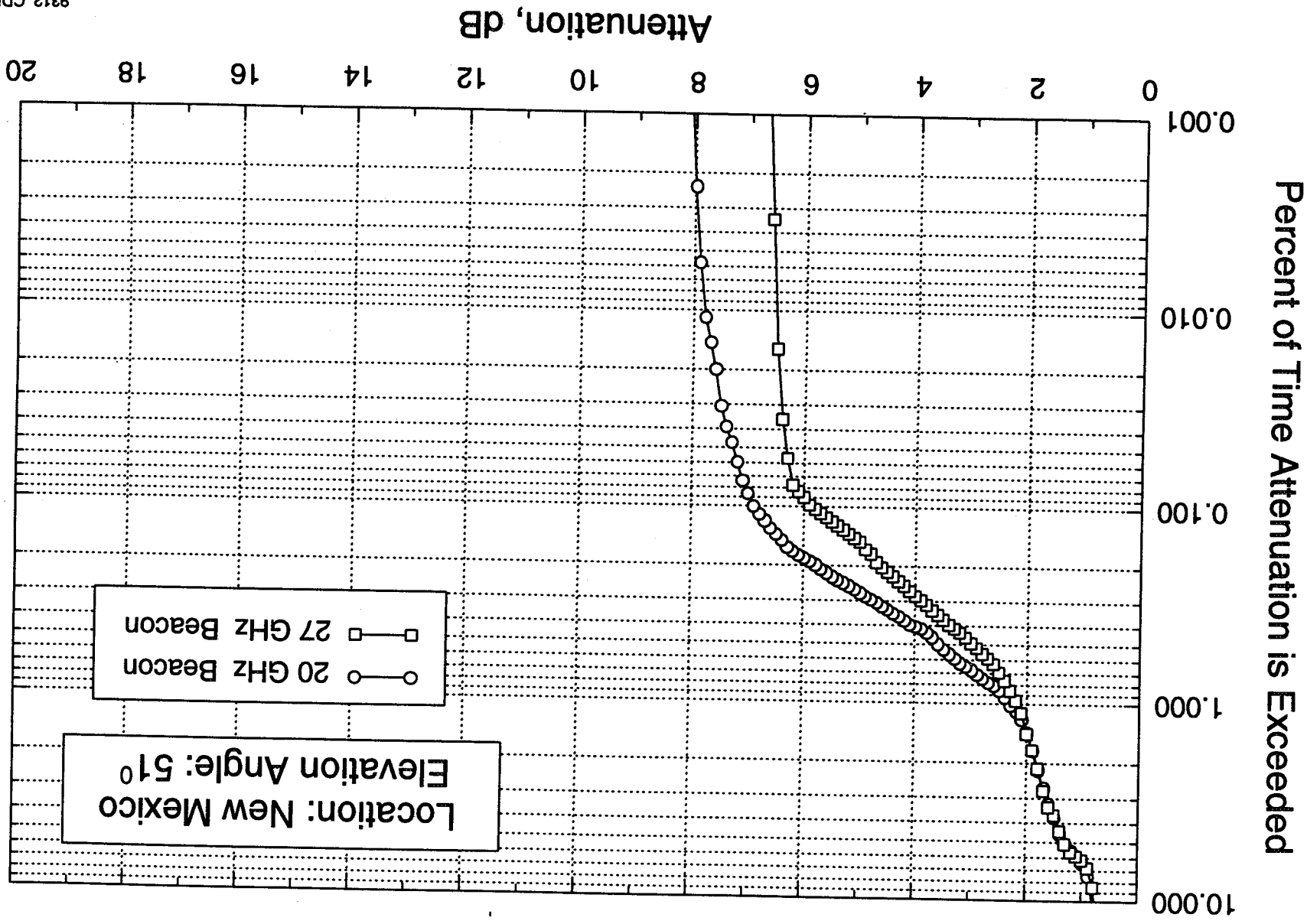
SITE CONFIGURATION



DATA ANALYSIS PRESENTATIONS

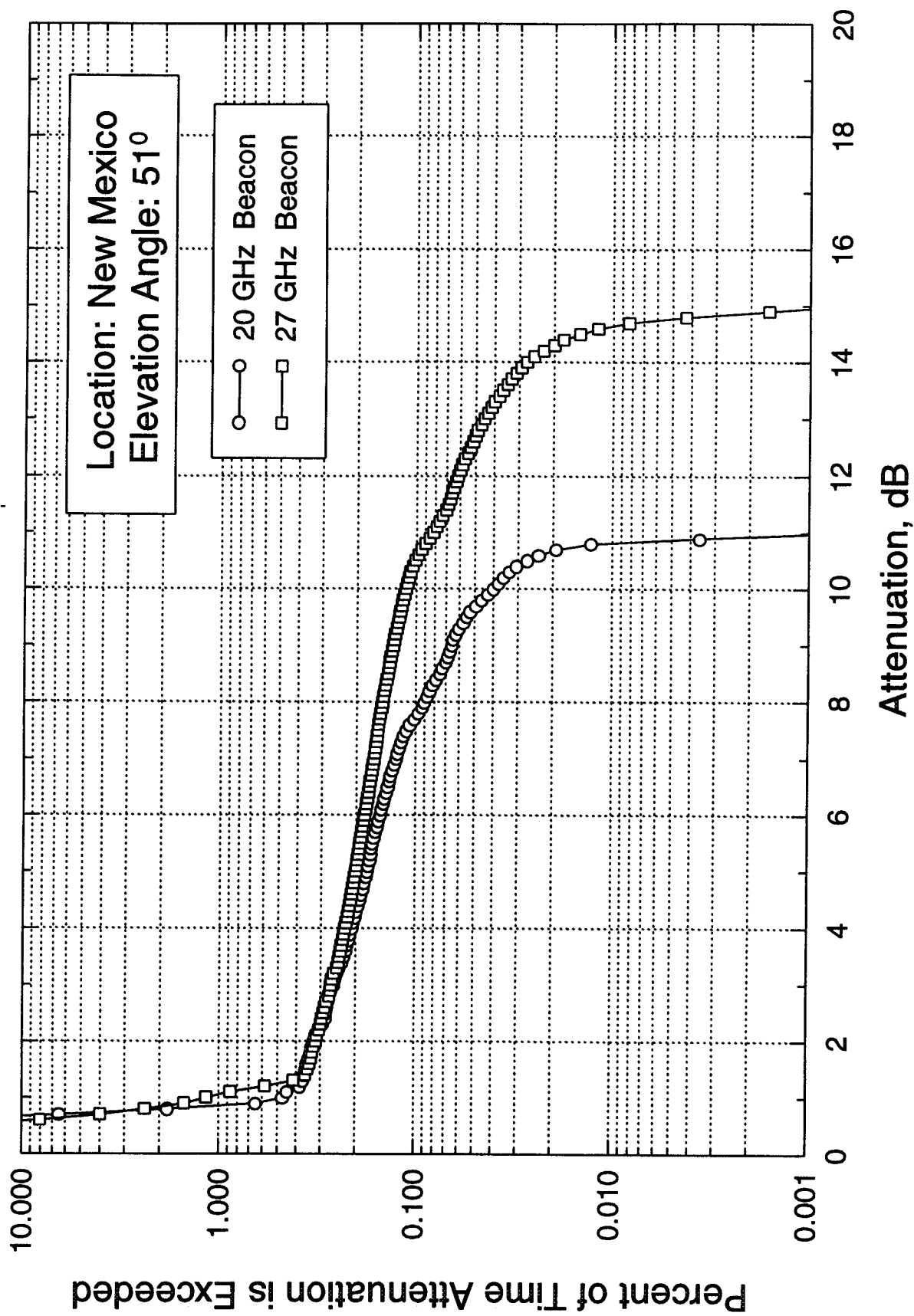
- ☐ MONTHLY CUMULATIVE DISTRIBUTIONS
- ☐ 4-MONTH CUMULATIVE DISTRIBUTIONS
- ☐ SUN PASS EVENTS, MARCH 1994
- ☐ ACTS \ TDRS FADE EVENTS
- ☐ ACTS \ TDRS CDF EXTRAPOLATIONS

Monthly Cumulative Distributions December 1993



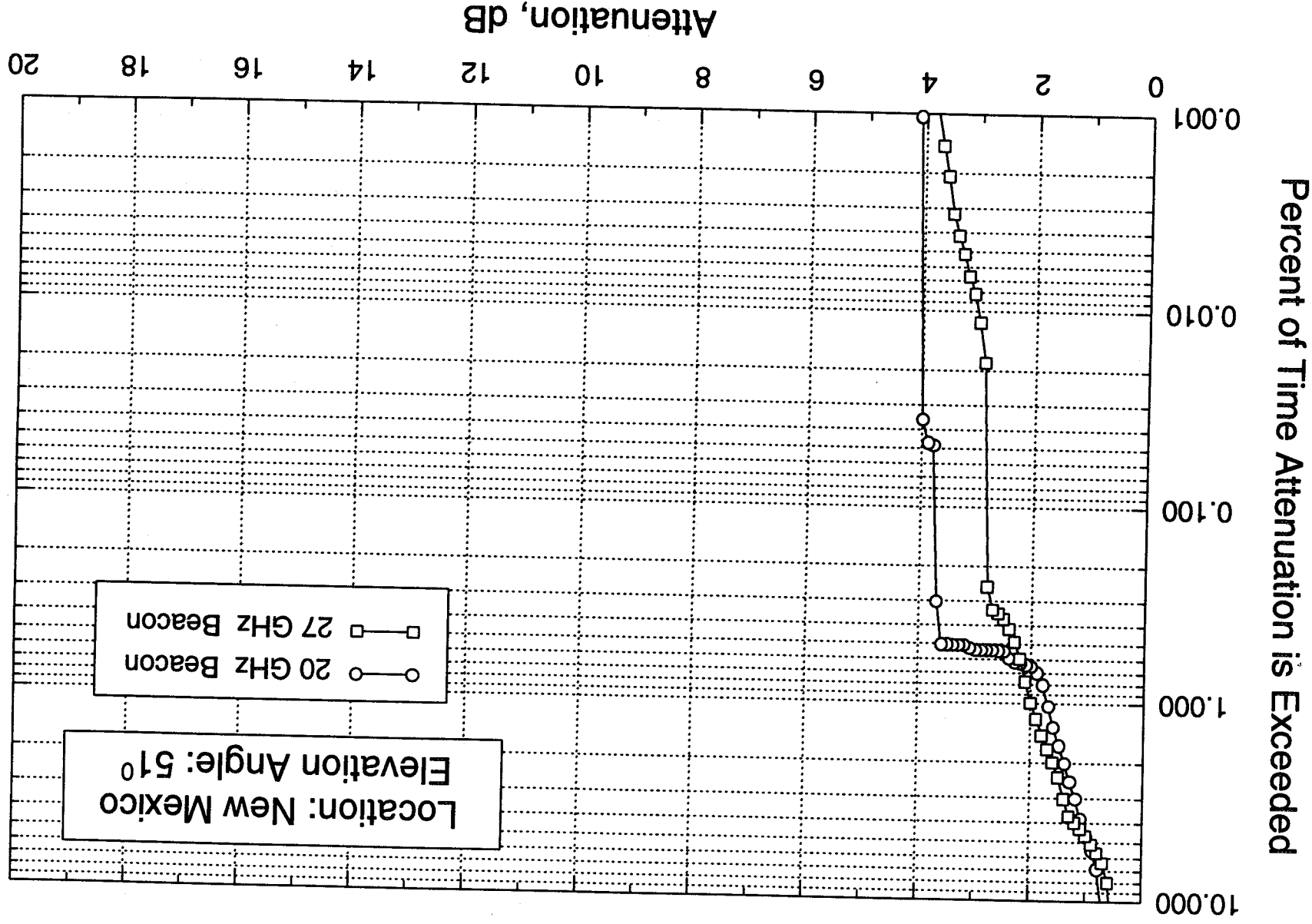
Monthly Cumulative Distributions

January 1994



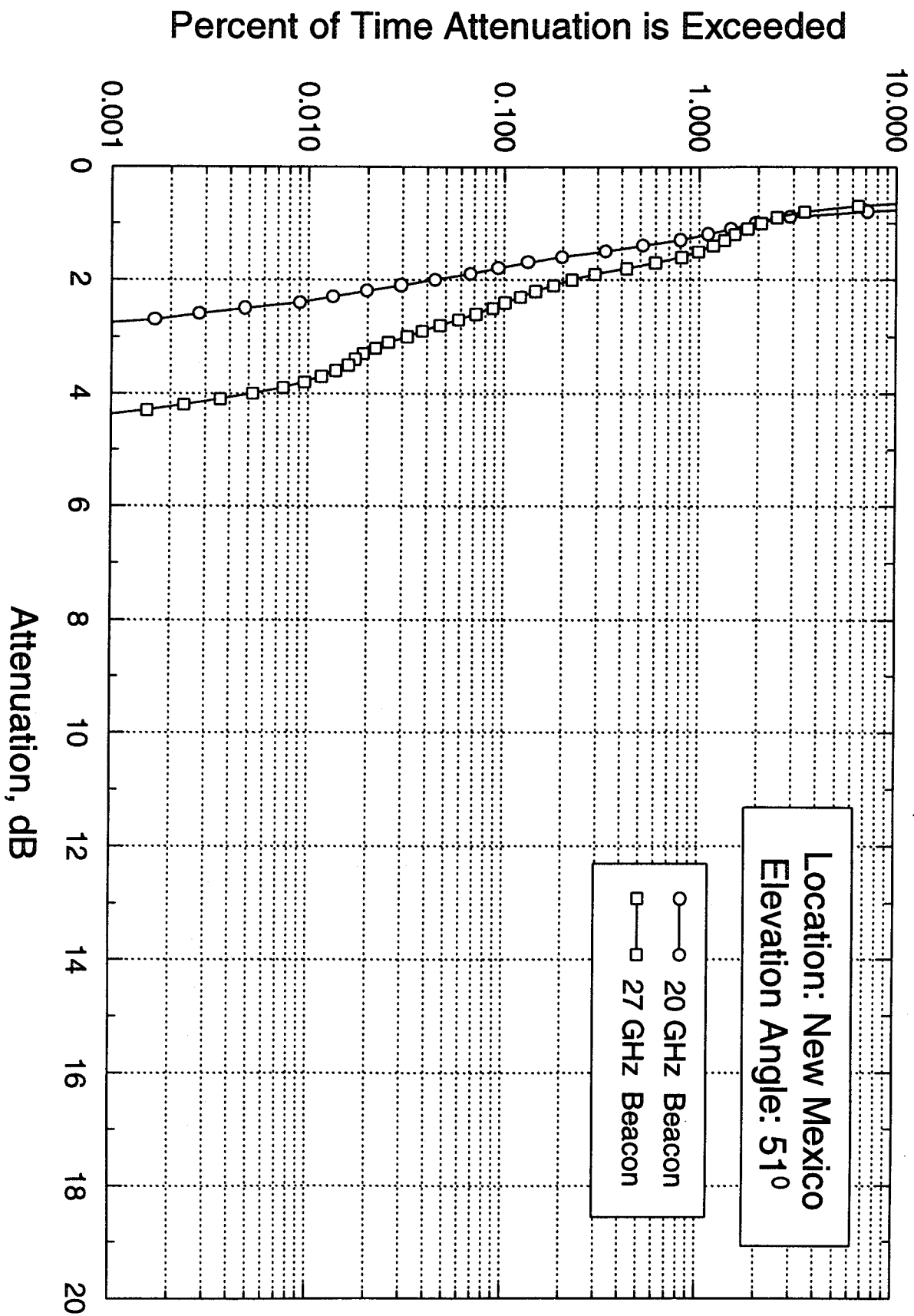
Monthly Cumulative Distributions

February 1994

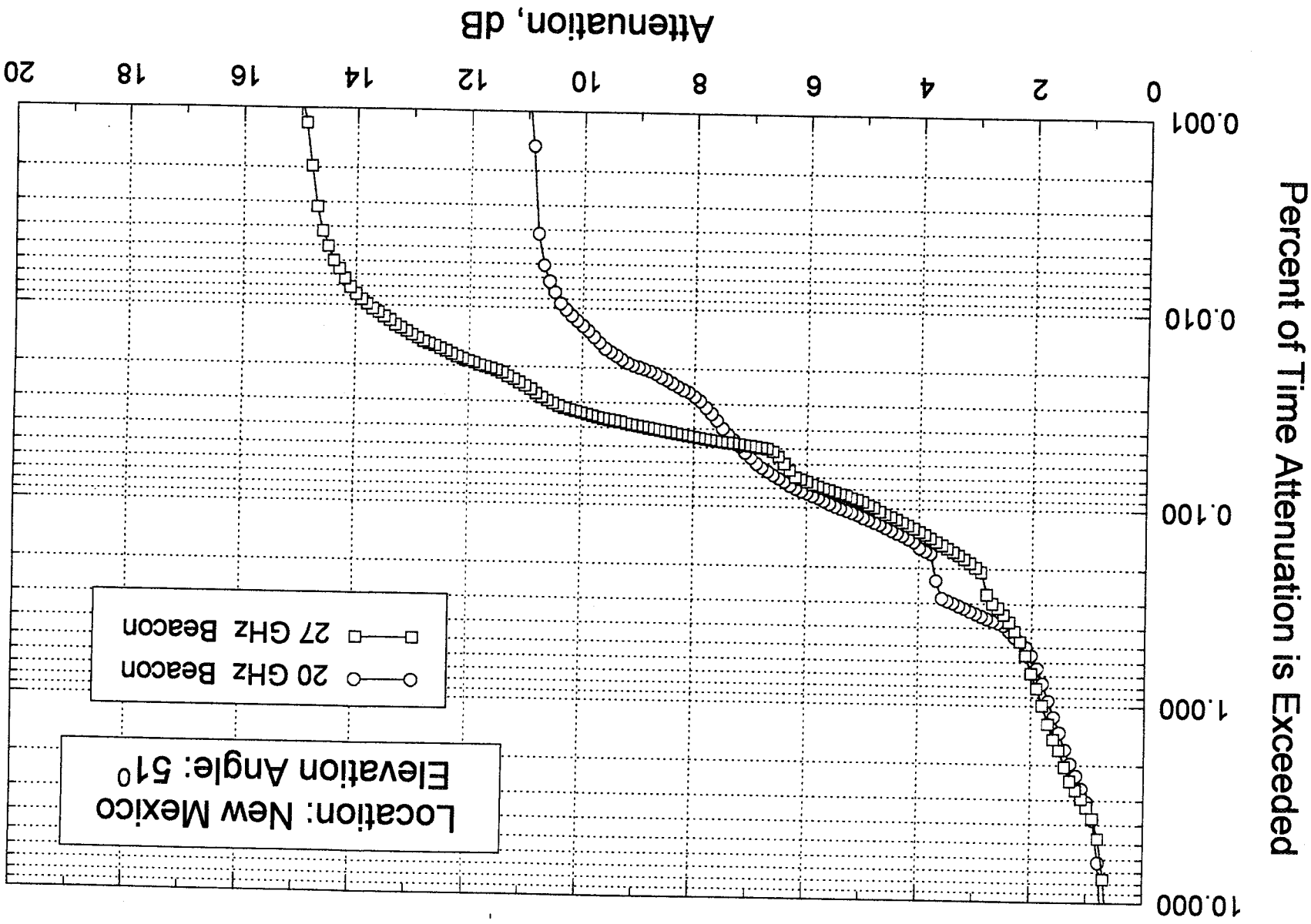


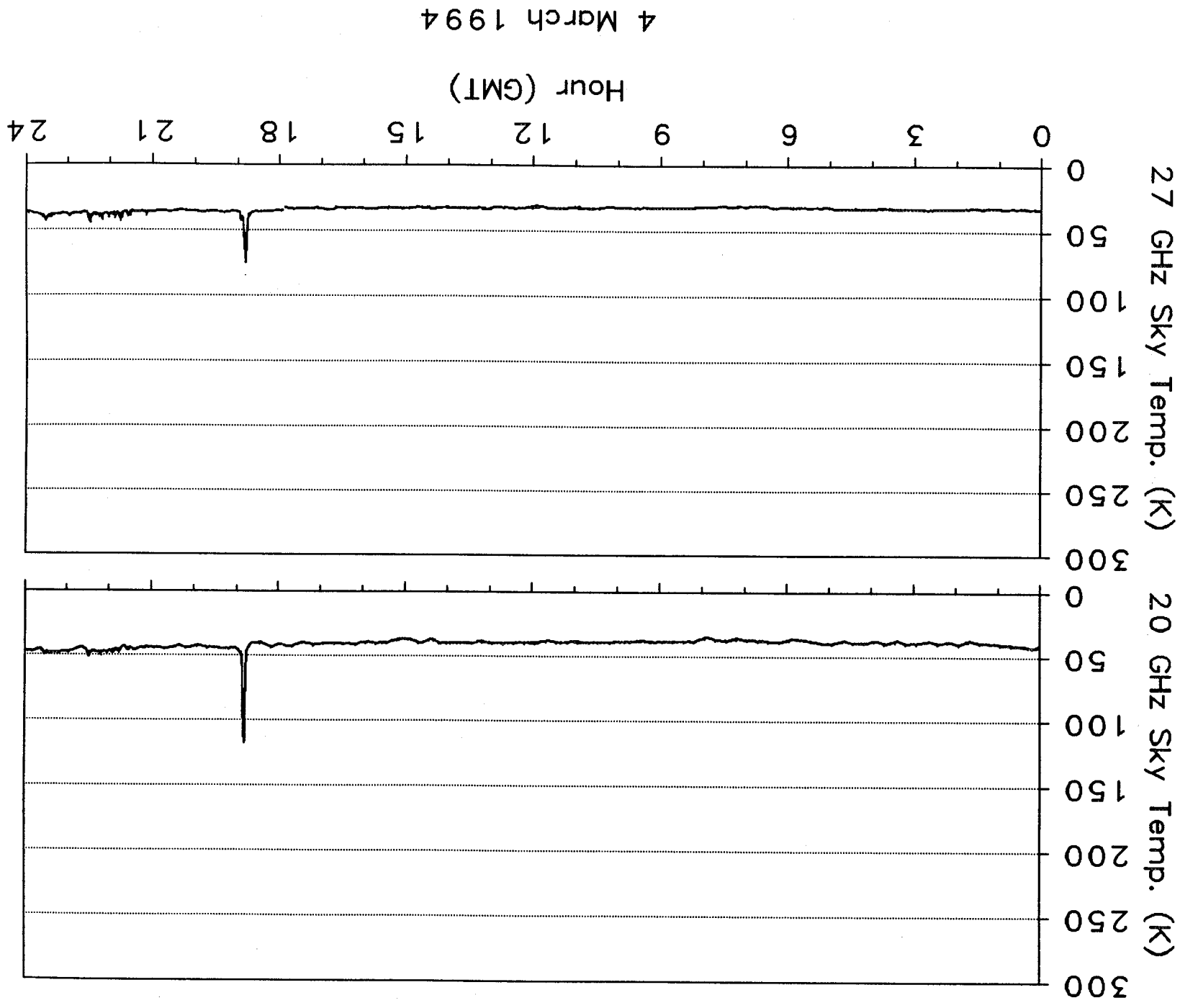
Monthly Cumulative Distributions

March 1994

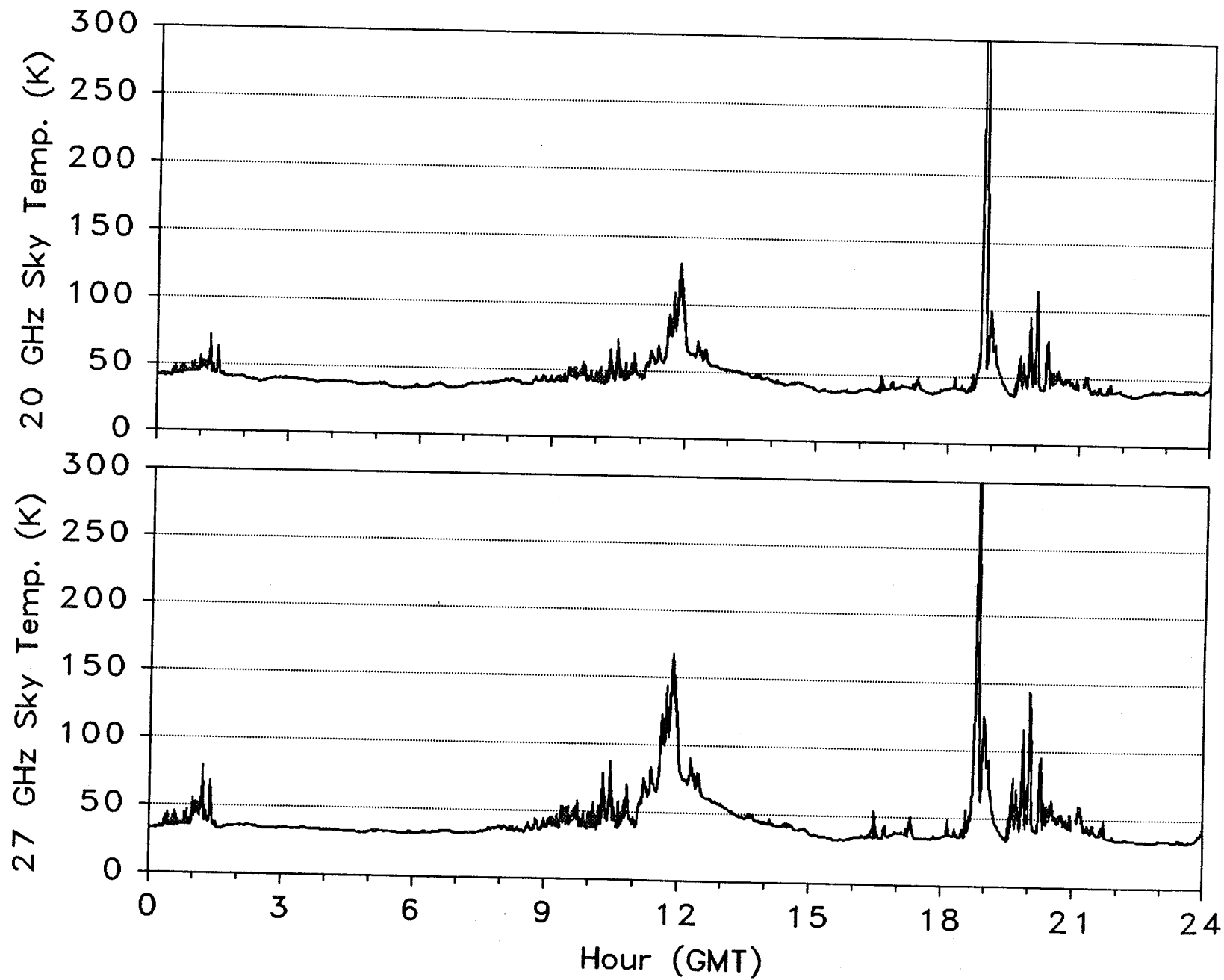


Four-Month Cumulative Distribution December 1993 - March 1994

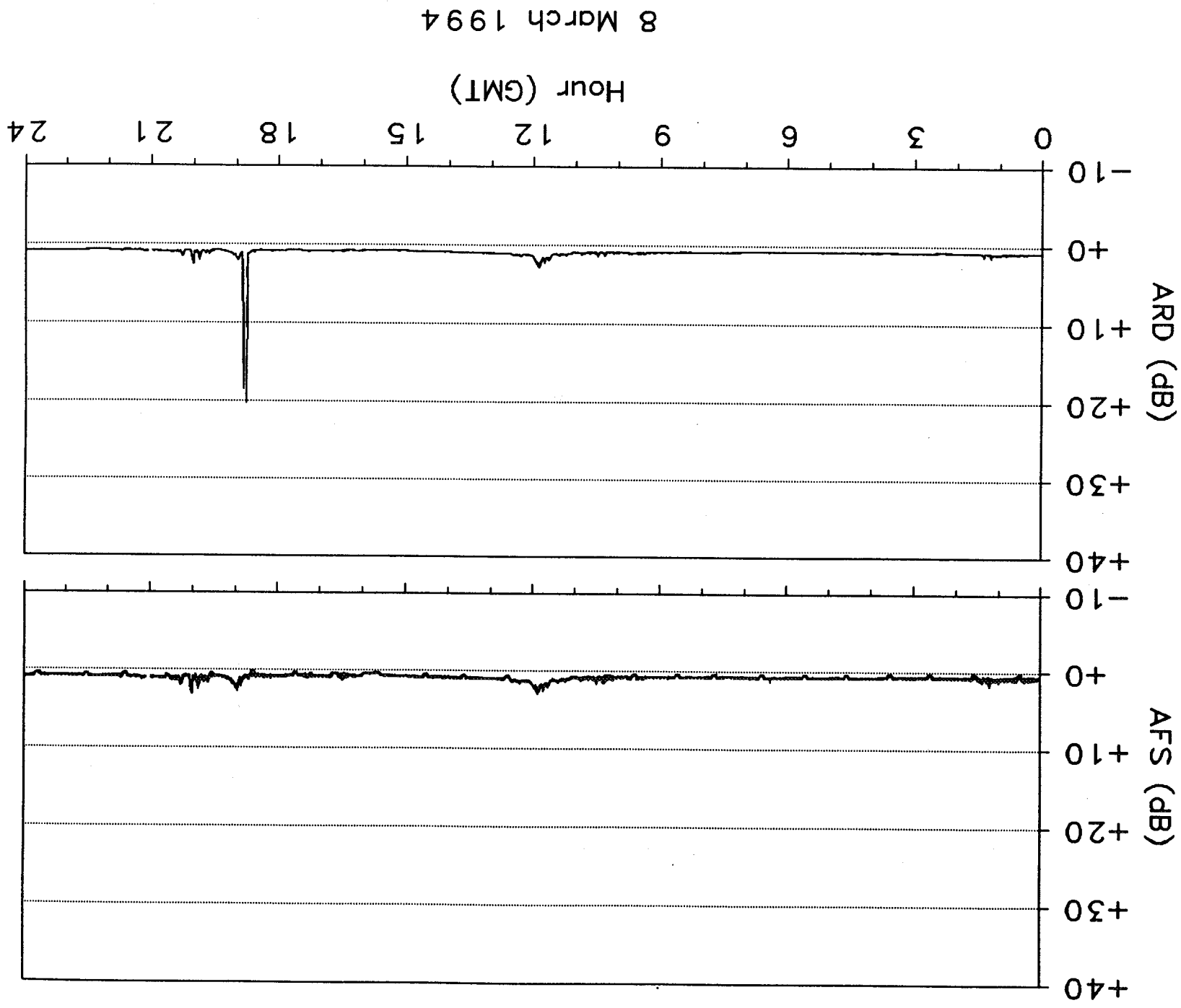




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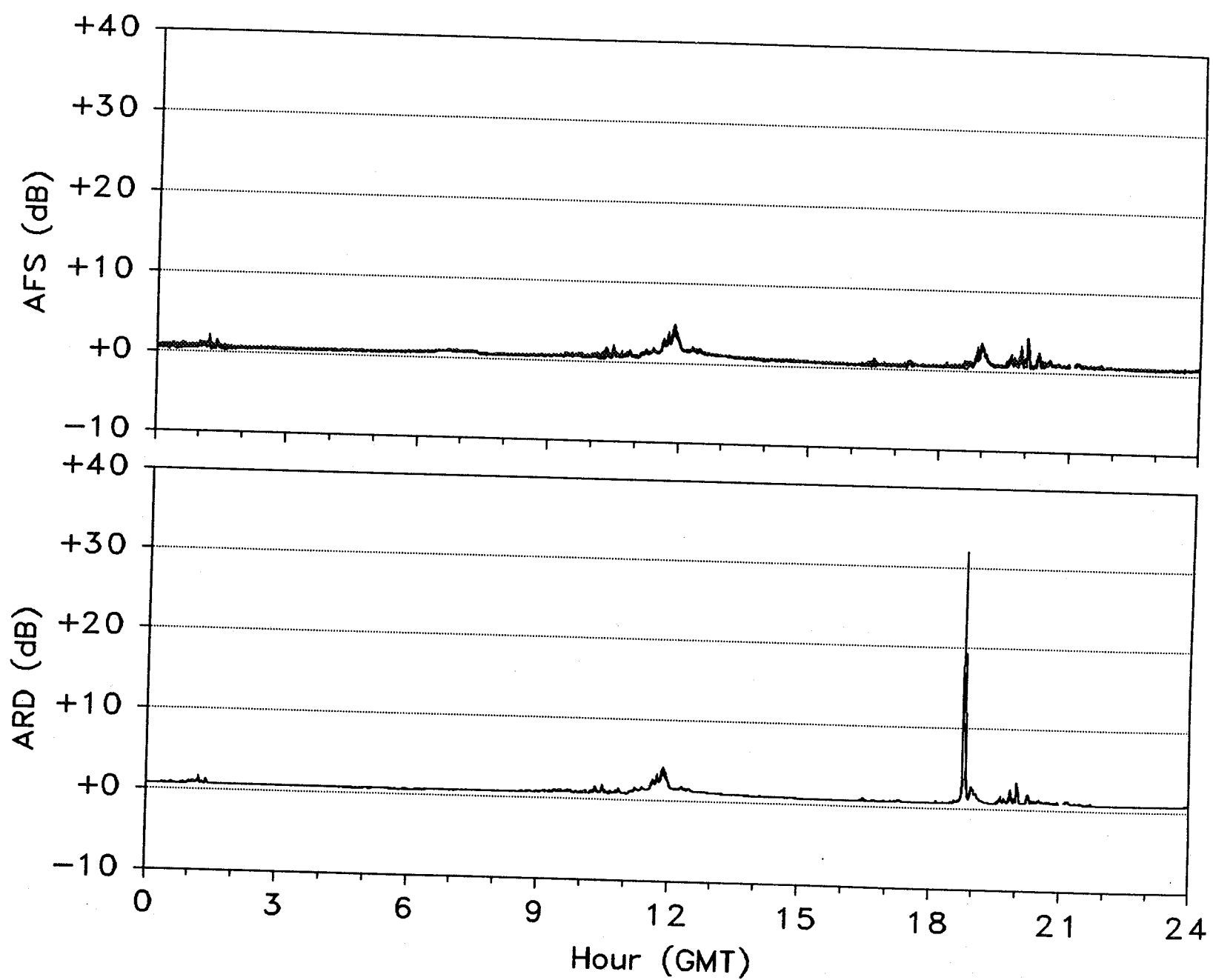


8 March 1994



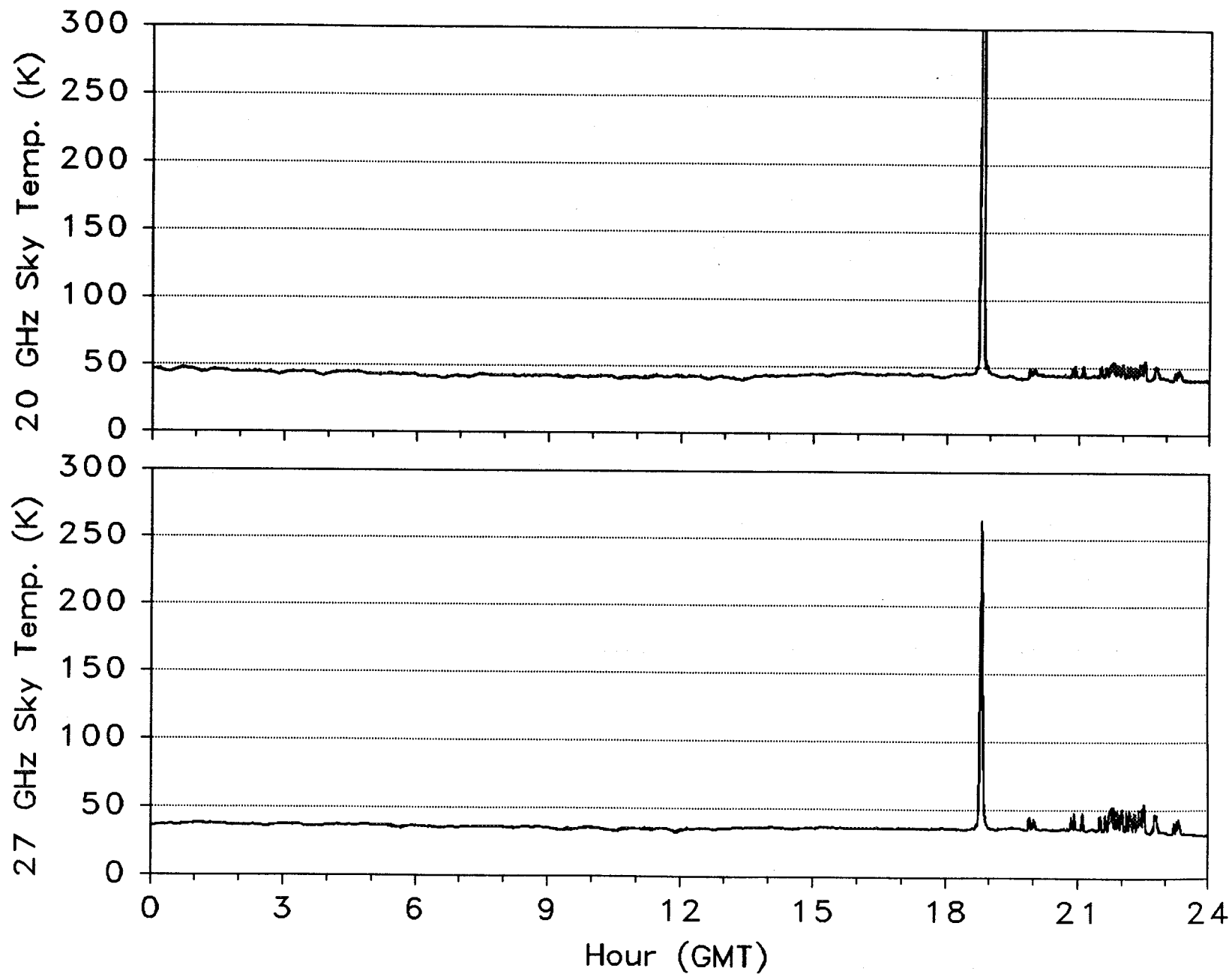
8 March 1994

441



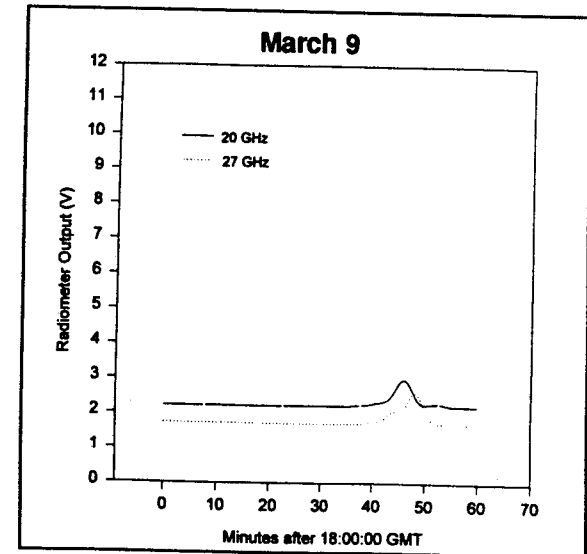
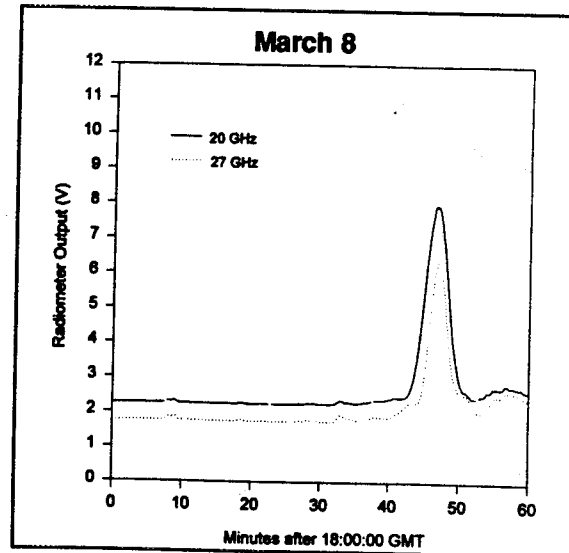
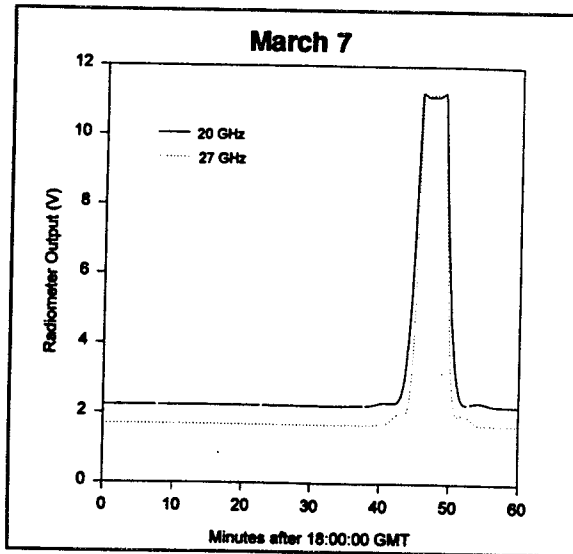
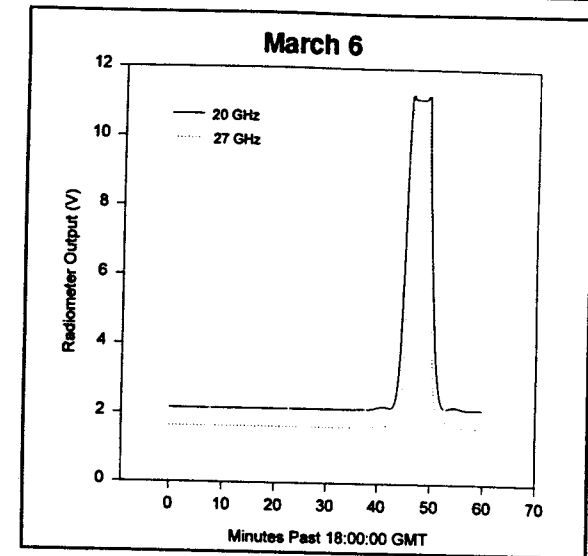
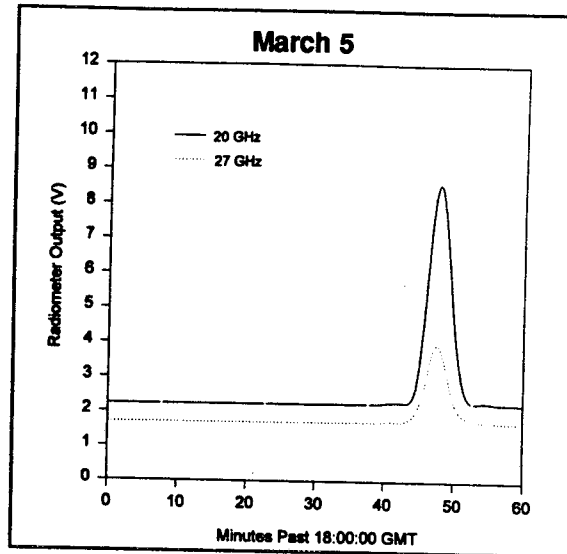
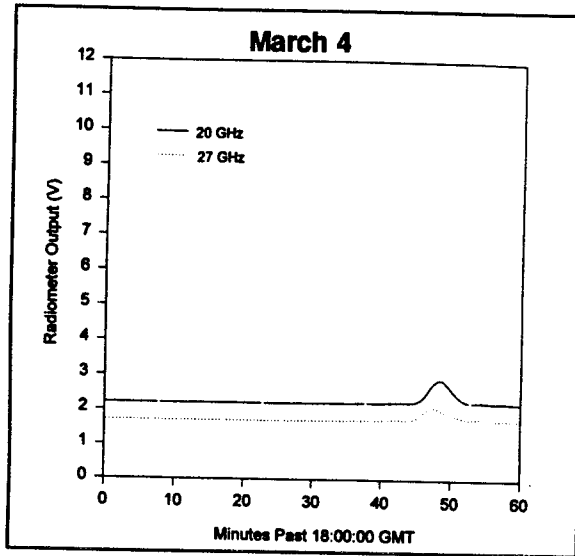
8 March 1994

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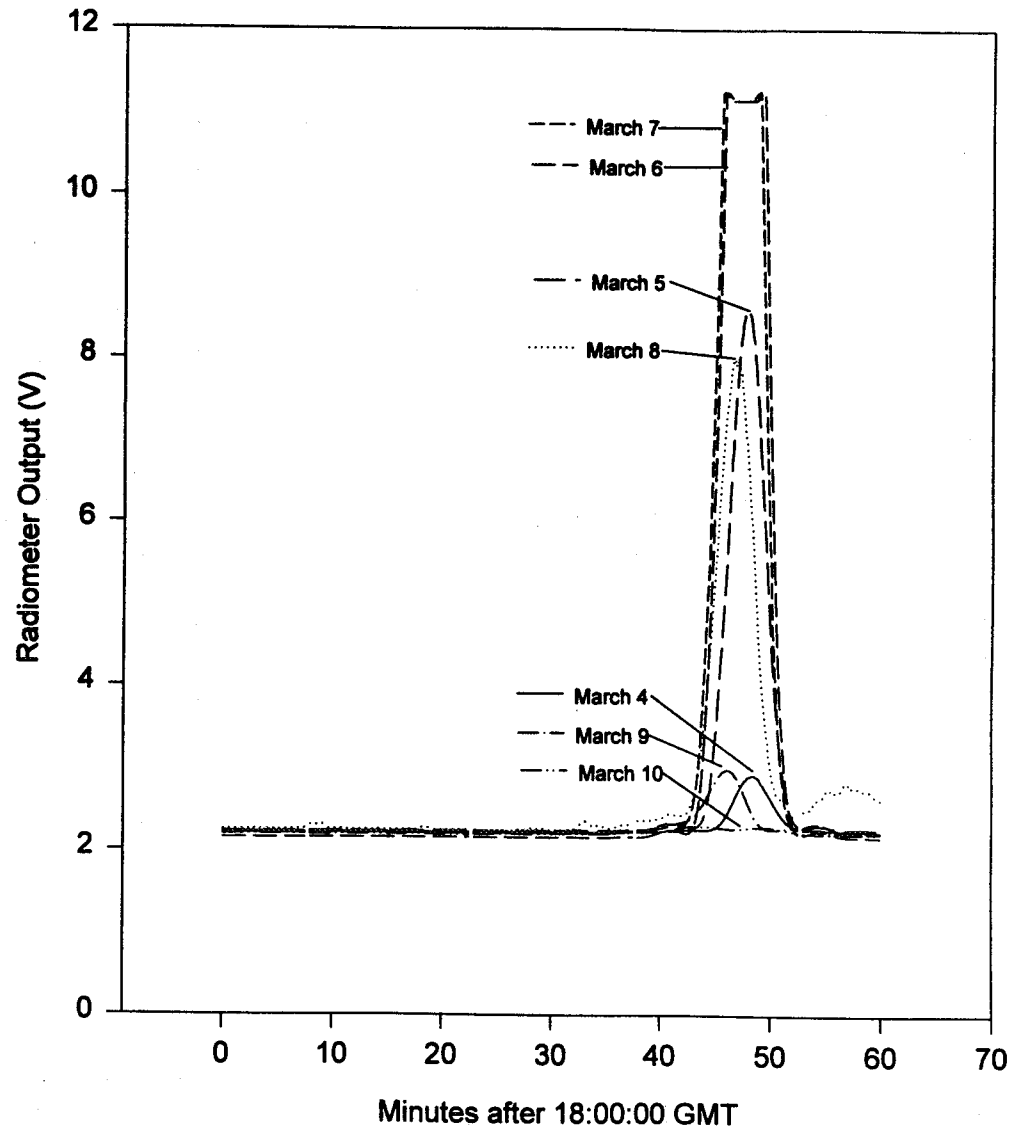
5 March 1994

Summary of Sun Pass, March 1994



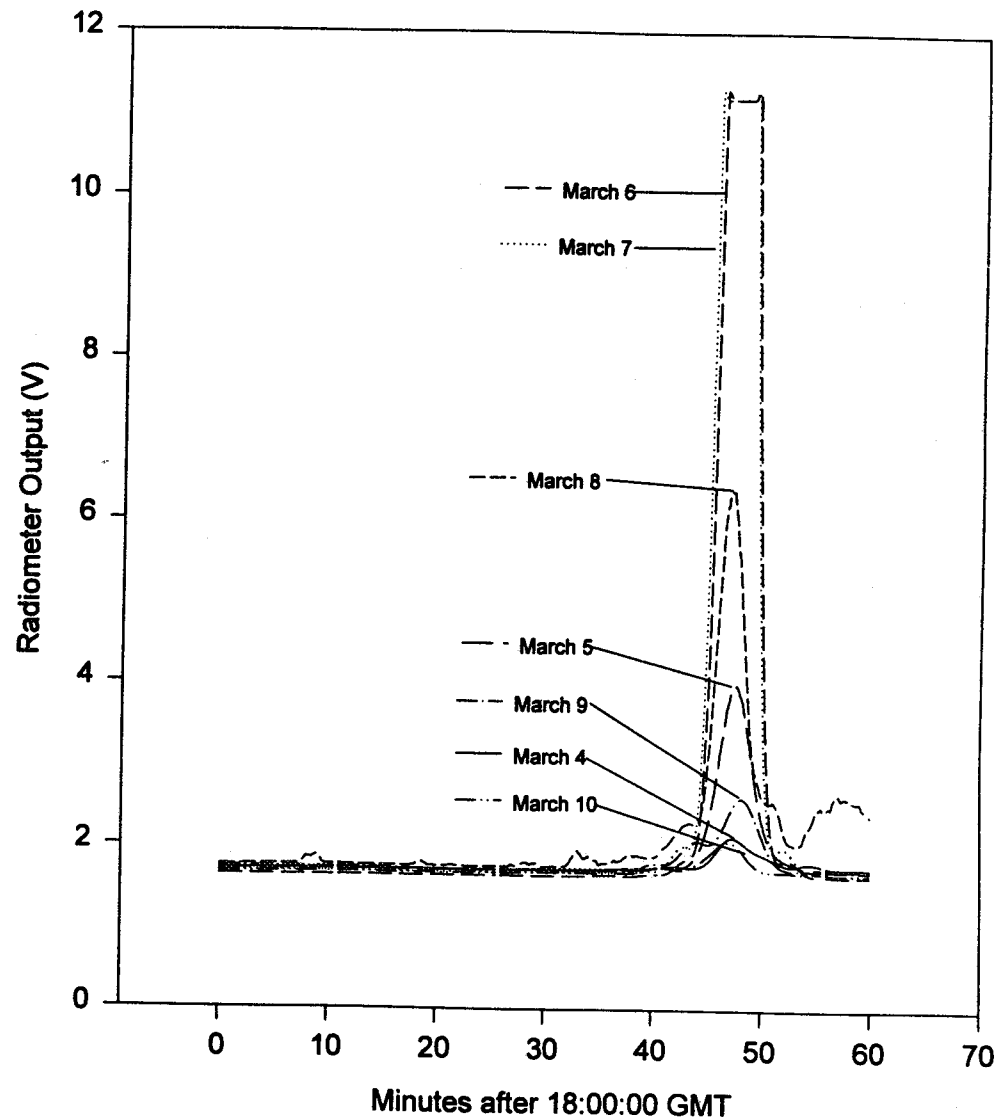
Summary of Sun Pass, March 1994

Comparison of 20GHz



Summary of Sun Pass, March 1994

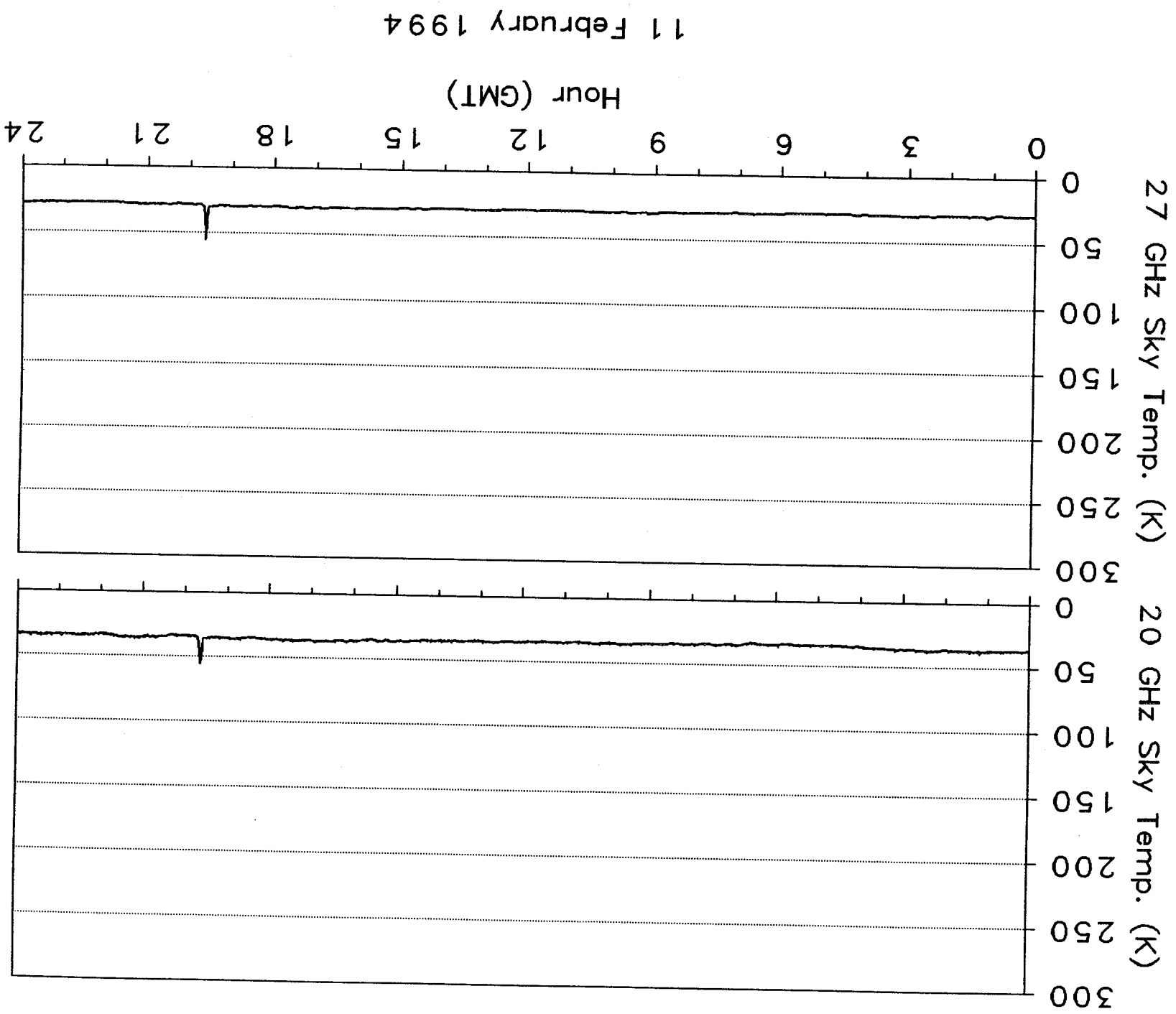
Comparison of 27GHz

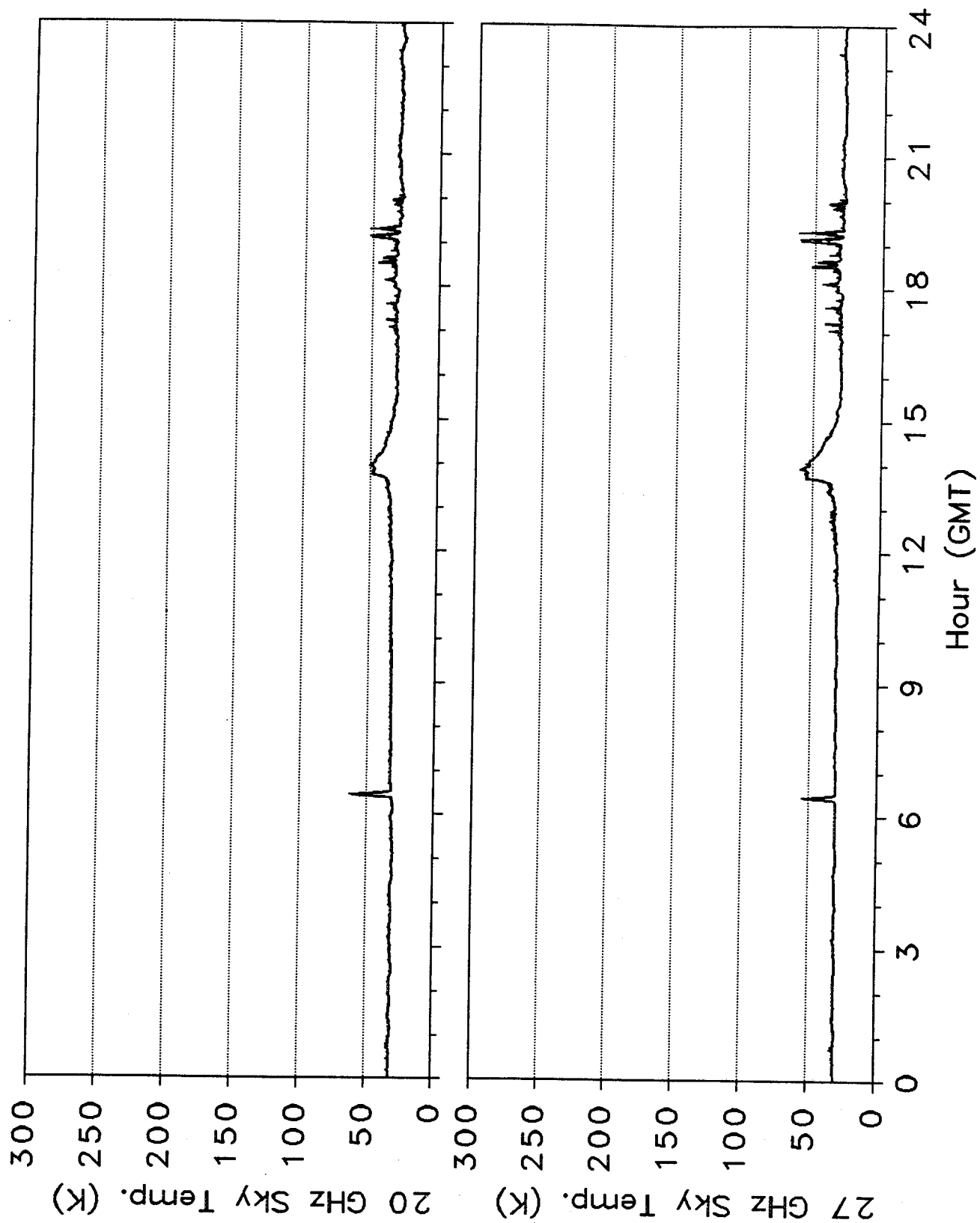


Summary of Sun Pass, March 1994

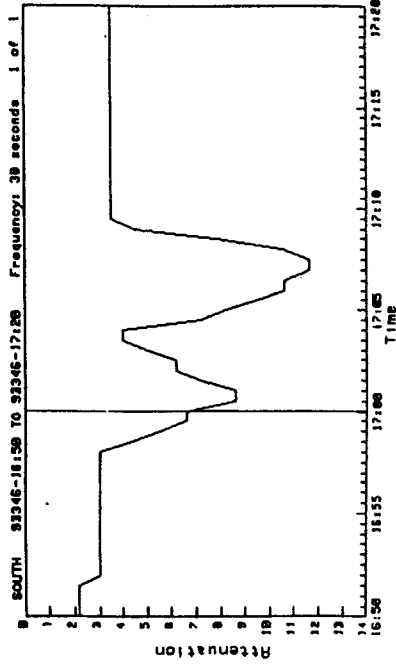
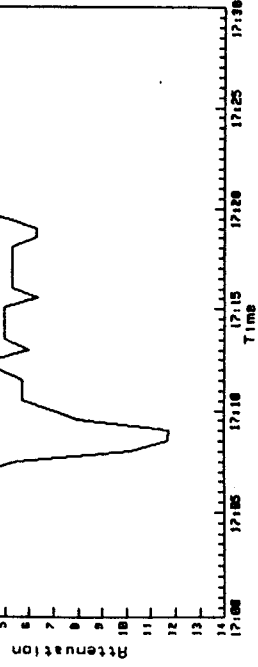
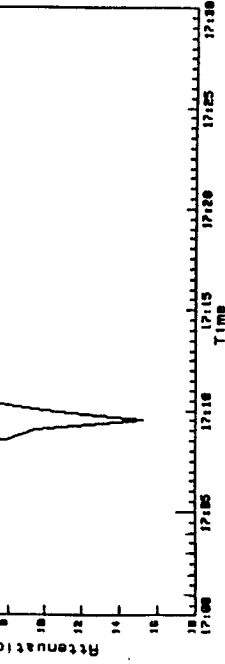
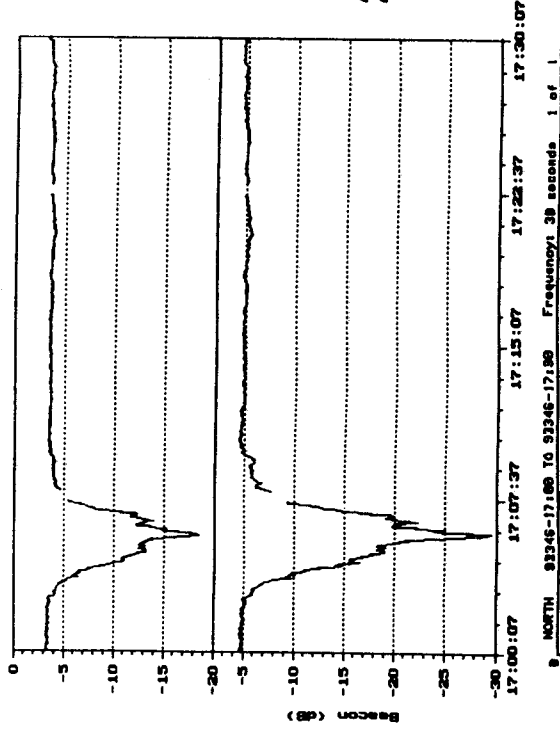
Location: New Mexico

| Date | 20 GHz | | | | 27 GHz | | | | 27 GHz Lead Time |
|------|----------|--------------|--------------|---------------|----------|--------------|--------------|---------------|------------------------|
| | Duration | 3-dB Time | Peak Time | Peak Temp. | Duration | 3-dB Time | Peak Time | Peak Temp. | |
| 3-4 | 6:35 | 3:50 | 18:48:25 | 120K | 7:35 | 4:25 | 18:47:20 | 75K | 0:00:55 |
| 3-5 | 8:50 | 5:50 | 18:47:45 | 400K | 9:35 | 3:25 | 18:47:35 | 270K | 0:00:10 |
| 3-6 | 11:40 | 5:00 | 18:47:30 | > 450K | 11:50 | 4:10 | 18:47:35 | > 450K | -0:00:05 |
| 3-7 | 11:45 | 5:00 | 18:47:15 | > 450K | 13:05 | 4:20 | 18:47:10 | > 450K | 0:00:05 |
| 3-8 | 14:35 | 3:45 | 18:46:50 | 350K | 15:50 | 2:50 | 18:47:10 | 300K | -0:00:20 |
| 3-9 | 8:45 | 3:45 | 18:46:10 | 120K | 11:35 | 3:40 | 18:48:05 | 125K | -0:01:50 |
| 3-10 | 2:15 | xx | 18:43:40 | 50K | 6:30 | xx | 18:47:05 | 70K | -0:03:25 |



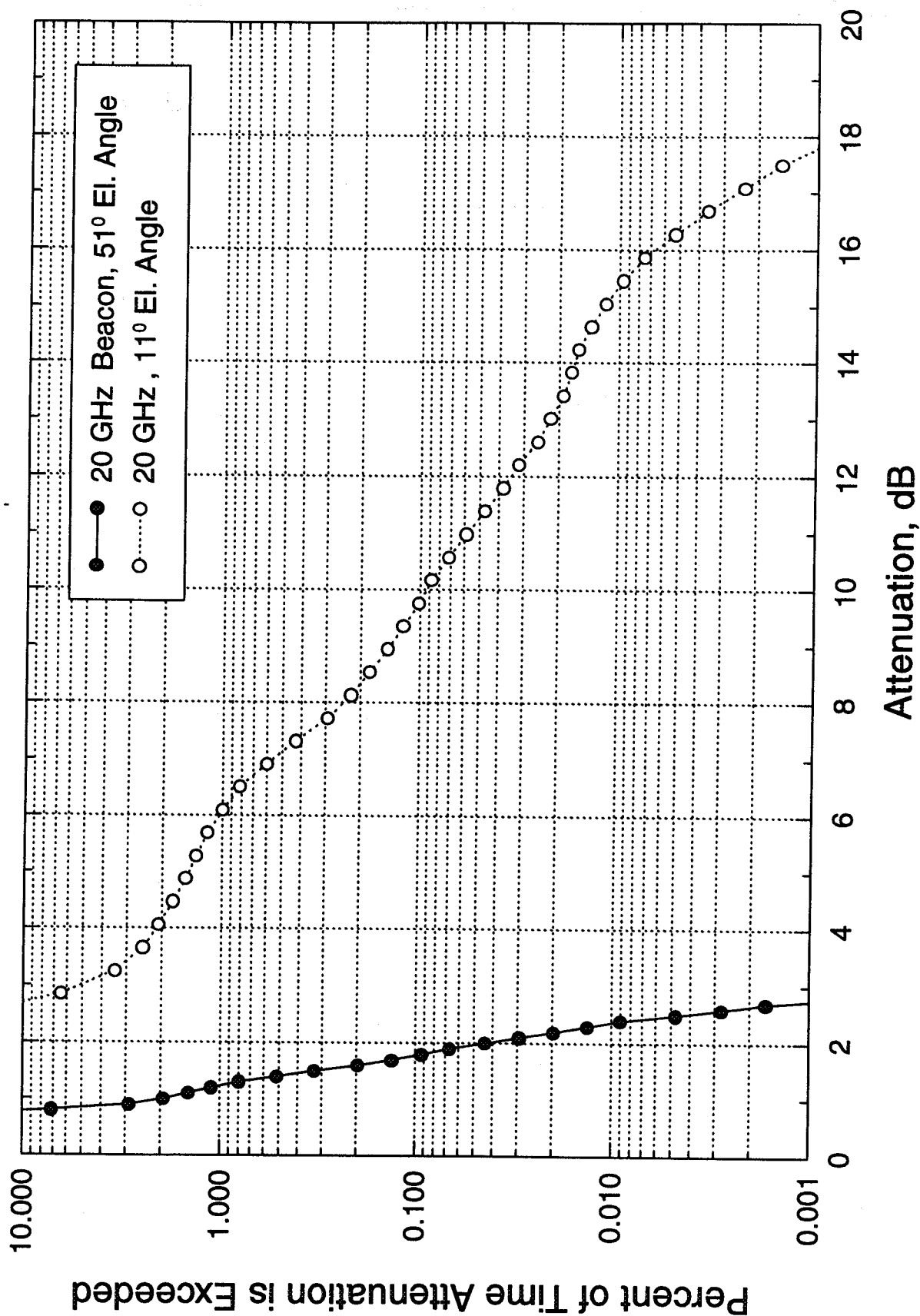


RAIN EVENT, WHITE SANDS GROUND TERMINALS, Dec. 12, 1993



EXTENSION OF ACIS MEASUREMENTS TO TDRS LINKS

March 1994



PLANS FOR NEXT REPORTING PERIOD

- ☐ RESOLUTION OF 'RAINDANCE" DATA TIME TAGS AND EVENT ANALYSES WITH ACTS DATA
- ☐ GENERATION OF DYNAMIC FADE STATISTICS FOR AVAILABLE DATA FILES
- ☐ FURTHER MODEL DEVELOPMENT AND SIMULATIONS FOR LOW ELEVATION ANGLE AND VARIABLE ELEVATION ANGLE STUDIES
- ☐ EVALUATION OF RAIN RATE MEASUREMENTS AND INCLUSION IN DATA STATISTICS
- ☐ DEVELOPMENT OF LONG TERM STATISTICS MODELING FOR TDRS LINKS

Georgia Tech ACTS Experiments

by

Daniel Howard

NOTE:

Georgia Tech has only recently joined the ACTS Propagation experimenter community. Consequently, no presentation was scheduled for Georgia Tech in this meeting. However, the following two charts have been provided to us for inclusion in the Proceedings by Daniel Howard, the principal investigator at Georgia Tech.

Georgia Tech ACTS Experiments

Daniel Howard

Assemble transmit/receive earth station from spare parts from Lewis and Ga Tech for a Class II Experiment

Use standard and custom waveform generation and reception equipment to perform RF Tests & Measurement through MSM in Loopback Mode

- Analog Measurements (ETE Noise Figure, Frequency and Phase Response, etc.)
- Digital Measurements (BER, Jitter, etc.)

Correlate RF signal measurements with weather data

- Use same weather monitoring equipment as Class I Experiments if possible
- Augment with additional weather data:
 - Doppler radar maps
 - Downloaded data from National Weather Service
 - Additional weather measurements in propagation path

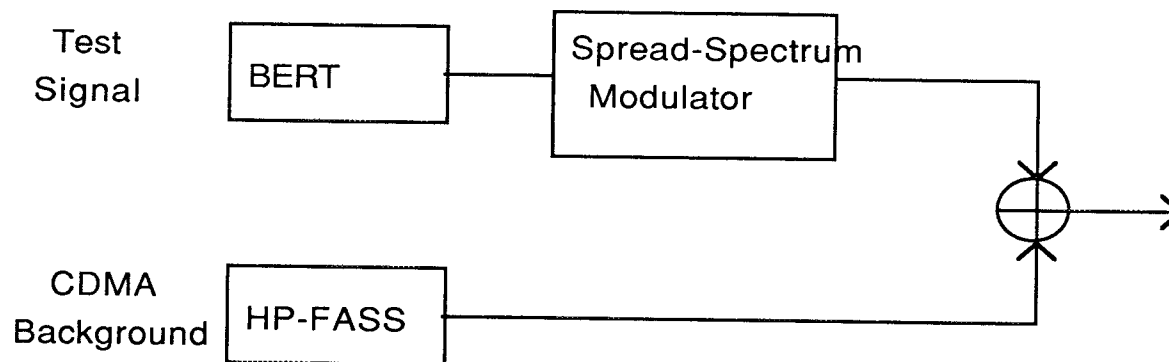
GT ACTS Experiment Phases

Phase I : Terminal and link RF Measurements:

- CW, Swept CW, noise, PSK, SBM modulations used for typical end-to-end link characterization measurements in two environments:
 - Clear Air
 - Inclement weather

Phase II : CDMA Measurements

- Use lab equipment to generate CDMA test signal with background CDMA traffic:



- Build code deinterleaver for BER measurements
- Use Spectrum Analyzer and Digital Waveform Capture for signal snapshots
- Scintillation effects on CDMA as key point of interest

REPORT OF THE WORKING GROUPS PLENARY MEETING

D.V. Rogers and R.K. Crane

As is customary at ACTS Propagation MiniWorkshops, the Science and Systems Working Groups met in Plenary Session to discuss issues related to the experiments being conducted with the ACTS Propagation Terminals. The main issues addressed were terminal/sensor calibration and data preprocessing. Results of this meeting are provided here.

I. Meteorological Sensor Calibration

A. Capacitance Rain Gauge

Much of the calibration discussion concerned the Young capacitance rain gauge that is supplied with the ACTS Propagation Terminal (APT). Several experimenters reported difficulties with the gauge, ranging from readings during periods of no rain, to an absence of readings on occasion in spite of clear evidence (*e.g.*, wet ground and reports from observers) of rain at the site. J. Goldhirsh (APL) reported good performance for many months with two gauges, and emphasized the importance of maintenance and frequent calibration of these devices for quality control.

ACTIONS:

After some discussion, the WGs prescribed a rain gauge calibration procedure to be performed once-per-week as follows:

- i) fill and purge rain gauge with water and allow at least 1.5 min for gauge to completely purge;
- ii) fill gauge (500 ml capacity) in five equal increments of 100 ml (data will be recorded by the data collection system);
- iii) ensure that rain gauge is purged of water at conclusion of test.

Experimenters should evaluate and record the performance of their rain gauge. S. Horan (NMSU) offered to receive weekly calibration data for each site on a monthly basis to evaluate the overall performance of the rain gauges. R.K. Crane (U. Oklahoma) will collaborate with D. Westenhaver (Auburn CCDS) to address the corresponding ACTSEdit issues.

B. Humidity Sensor

Some experimenters reported erroneous readings from the humidity sensors (*e.g.*, readings in excess of 100%). R. Henning (USF) noted that the DC voltage (≈ 17 V) supplied to the humidity sensor by the APT is below the

minimum (≈ 20 V) specified by the manufacturer. He was able to improve the performance by placing a battery in series with the supply voltage.

C. Mayer (U. Alaska) observed that the humidity sensor has a limited range of operating temperature, and that the sensor at the Alaska site was unable to operate during the coldest part of the winter. J. Goldhirsh asked if there are elements within the unit that should be replaced periodically, or if calibration were required. It was noted that the sensor should be placed so that it is out of direct sunlight. R. Henning stated that the manufacturer supplies an enclosure for the humidity sensor (\approx \$200) that seems to improve operation of the sensor. (The temperature sensor can also be placed in the same enclosure.)

ACTIONS:

D. Westenhaver stated that 20 VDC can be supplied by a barrier strip in the APT. He will determine and specify the appropriate modification to the experimenters.

Westenhaver will also distribute information on sensor enclosures provided by R. Henning and W. Vogel (U. Texas/ACTS Data Center). All sites should purchase or otherwise implement a suitable enclosure for the humidity sensor.

C. Anemometer

Some experimenters reported occasions when wind speeds recorded by the anemometer clearly appeared to be lower than actual speeds. R. Crane noted that the sensor cover can apparently be penetrated by water during rainfall, and that provision of drain holes might be necessary.

ACTION:

R. Crane will determine suitable locations to drill drain holes in the sensor enclosure, and specify the locations for the other experimenters.

II. *Beacon and Radiometer Calibrations*

Based on his presentations, "Radiometer Calibration Procedure" and "Beacon Attenuation Estimation Reference Level," which addressed calibration methodology in detail, R. Crane stated that the main remaining issue was what should be done with ACTSEdit to support reliable APT beacon and radiometer calibration procedures. (This item is also related to the preprocessing issues discussed below.)

The merits of establishing appropriate reference levels for the beacon and radiometer channels by essentially automatic means were emphasized. Iteration between beacon and radiometer readings improves the accuracy of both calibration sequences. Procedures can be defined to accomplish

beacon and radiometer calibrations in the desired automatic fashion, but they must be supported by ACTSEdit.

ACTION:

R. Crane and D. Westenhaver will collaborate to implement suitable automatic calibration procedures into ACTSEdit.

III. Data Preprocessing

A variety of data preprocessing issues were discussed, including reference-level estimation (calibration); removal of ranging spikes and level shifts from the 20-GHz beacon data; checking for extraneous bits in the cumulative distribution bins for beacon, radiometer and meteorological data; and formats for preprocessed data output from ACTSEdit to be used for data analysis.

R. Crane stated that the data flags should permit more designations than just the "good" or "bad" labels provided at present. At least a 2-bit status identifier should be provided. W. Vogel observed that data units greater than the current 16-byte limit could be used if desirable.

As the data preprocessing procedures are still under development, R. Hulays (UBC) asked what procedures should be followed in the meantime. There was additional discussion regarding importation of APT data into various spreadsheets for analysis support. Limitations were identified with some commercial spreadsheets for the data formats used in the data preprocessing software.

ACTIONS:

A Task Group composed of R. Crane, W. Vogel and D. Westenhaver was established to specify a fix for the data flagging and handling problems. Specifications for preprocessing procedures will address removal of 20-GHz beacon level variations caused by switches to/from ranging tones and radiometer and beacon calibrations via the iterative process (R. Crane). Data outputs for the beacon and radiometer channels will be final decibel levels for each channel.

A new program will be provided to automatically perform the preprocessing tasks and to supply summary information needed for the beacon and radiometer calibrations. The time required to preprocess one day of data should be less than 15 min. This program will generate a .PV1 file (format different from the .PV0 file currently generated by ACTSEdit).

In the meantime, currently-available data preprocessing procedures should continue to be used to assist in identifying data glitches, etc. Once

the automated procedures are available in software, it will be a simple matter to reprocess these data.

IV. Other Issues

C. Mayer observed that the 20-Hz fast data sampling rate planned to be used for some tropospheric scintillation events is not available, having been deleted in its original form when the software filter was modified. As summer is the season of maximum scintillation activity, this feature should be provided soon if it is to be most beneficial.

Although weekly status reports from experimenters are no longer requested by NASA, D. Westenhaver stated that he has found frequent reports from the experimenters to be very helpful in monitoring APT operation and keeping aware of field problems. He requested that frequent reporting continue.

ACTIONS:

D. Westenhaver will address the implementation of 20-Hz sampling capability as a priority item. He will continue to maintain close contact with the experimenters via the existing communication channels to stay apprised of terminal operation and to keep experimenters informed.